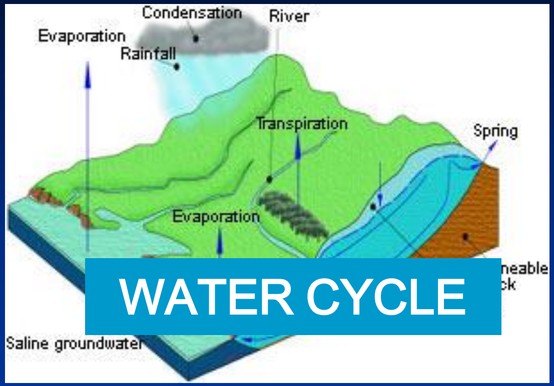
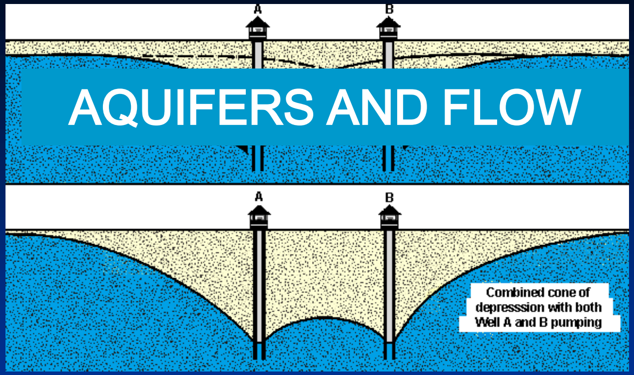

Condensation
River
Evaporation
Rainfall
Transpiration
Spring
Evaporation
WATER CYCLE
Saline groundwater


A
B
AQUIFERS AND FLOW
A
B
Combined cone of depresssion with both Well A and B pumping


DRILL


PROBLEMS
04 28 2005

Pumps & Wells


CONSTRUCT


PUMP

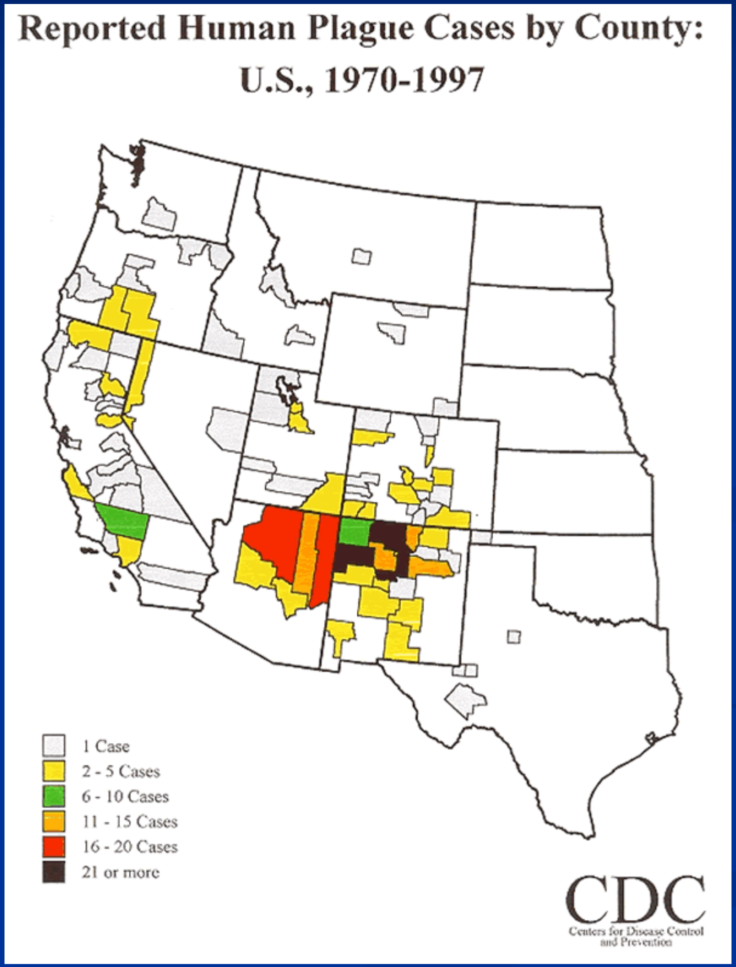

TEST

Well Health and Safety

What's the most stupid thing YOU'VE done?

Well Health and Safety - PPE

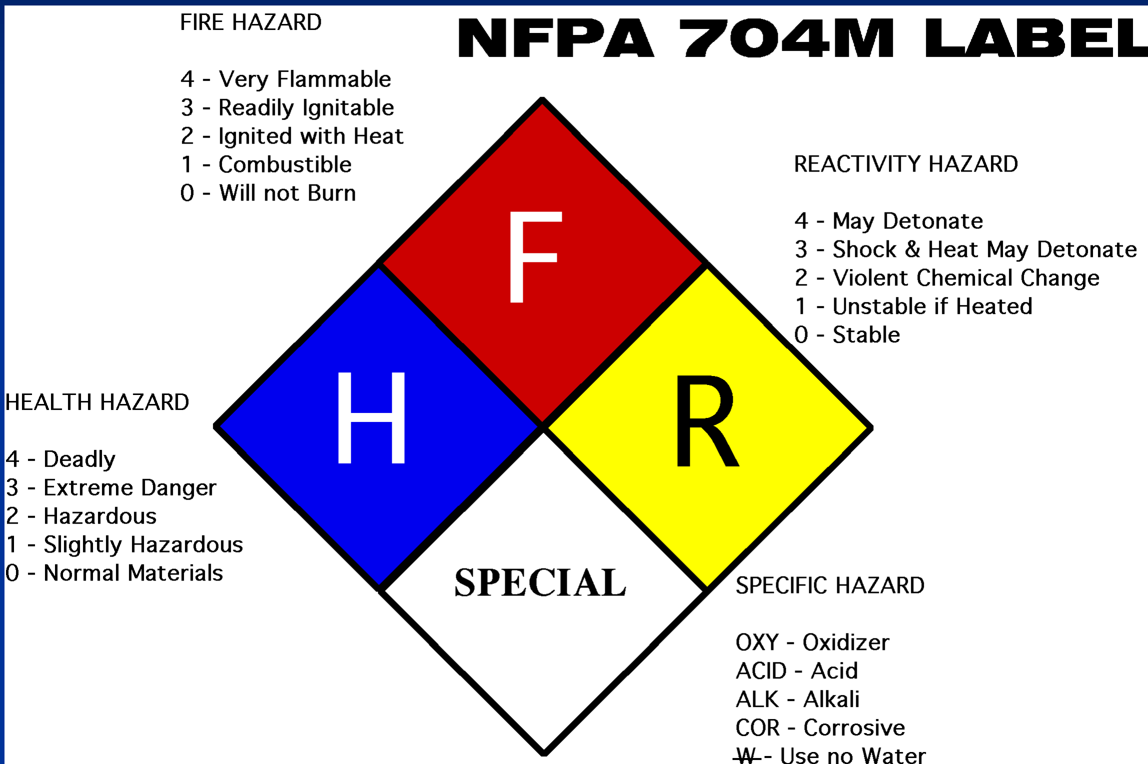
Well Health and Safety - Biological



Well Health and Safety – Energized Systems

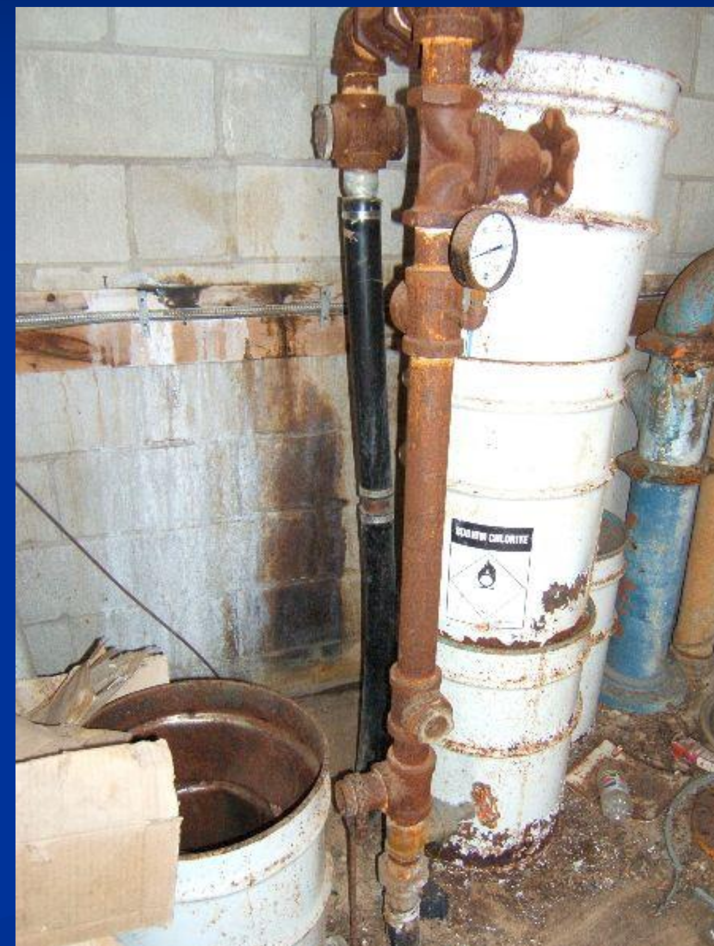
Well Health and Safety - OSHA

Well Health and Safety - Chemicals



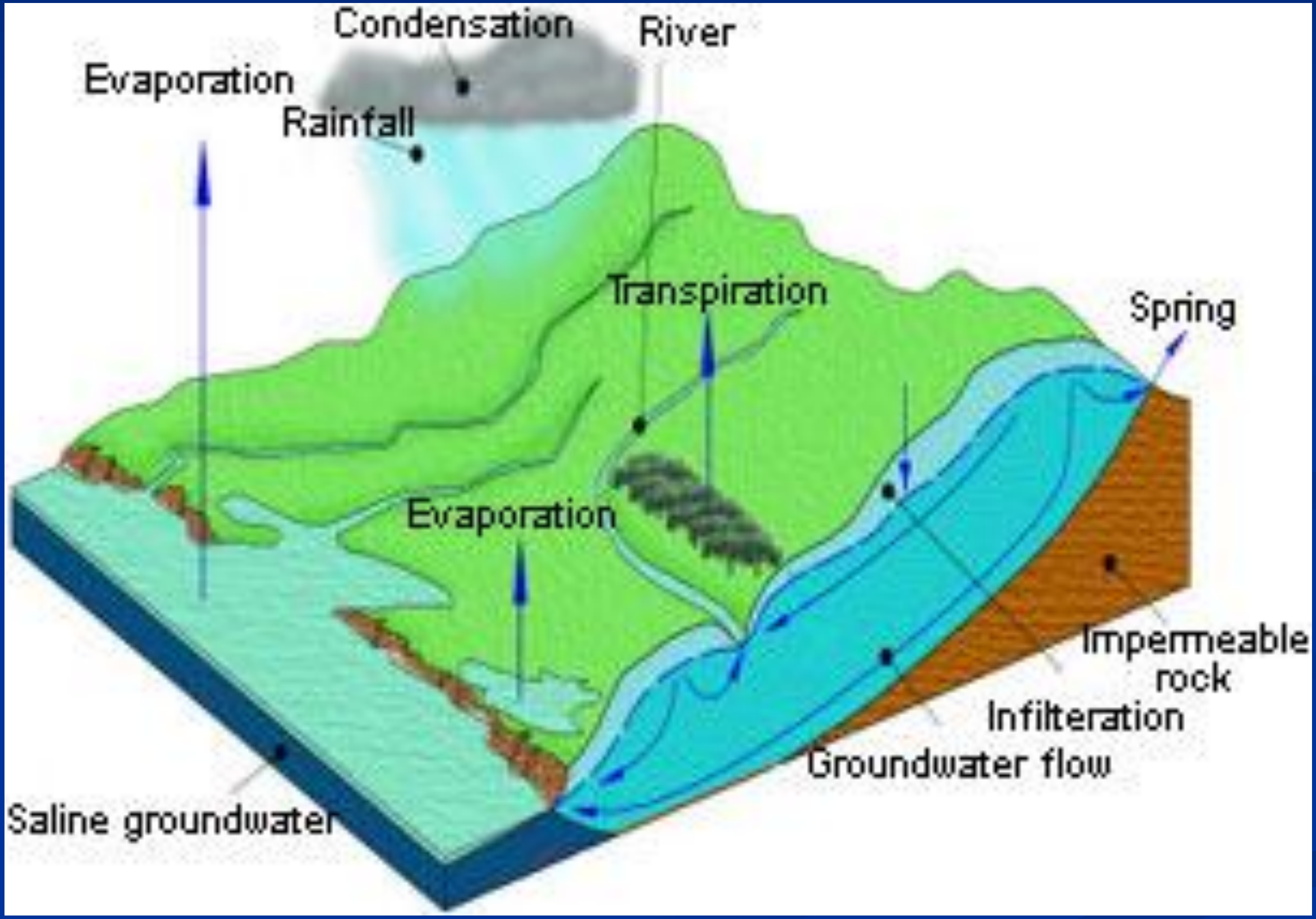
CHLORINE 7782505 3 0 0 Oxidizer

Health and Safety – Pop Quiz



WATER CYCLE

Classic Hydrologic Cycle



Time in Cycle

RESIDENCE TIME OF VARIOUS COMPONENTS OF HYDROLOGIC CYCLE

COMPONENT	RESIDENCE TIME (Avg.)
ATMOSPHERIC WATER	ABOUT 10 DAYS
SOIL MOISTURE	2 WKS-1 YR
RIVERS	ABOUT 2 WKS
SWAMPS	1-10 YRS
LAKES & RESERVOIRS	ABOUT 10 YRS
GROUND WATER	2 WKS-10,000 YRS

(AFTER FREEZE AND CHERRY, 1979)

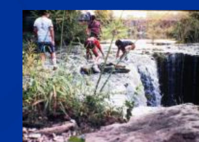
Water Budget

Precipitation – **Evapotranspiration** – **Streamflow =**

–

–

=



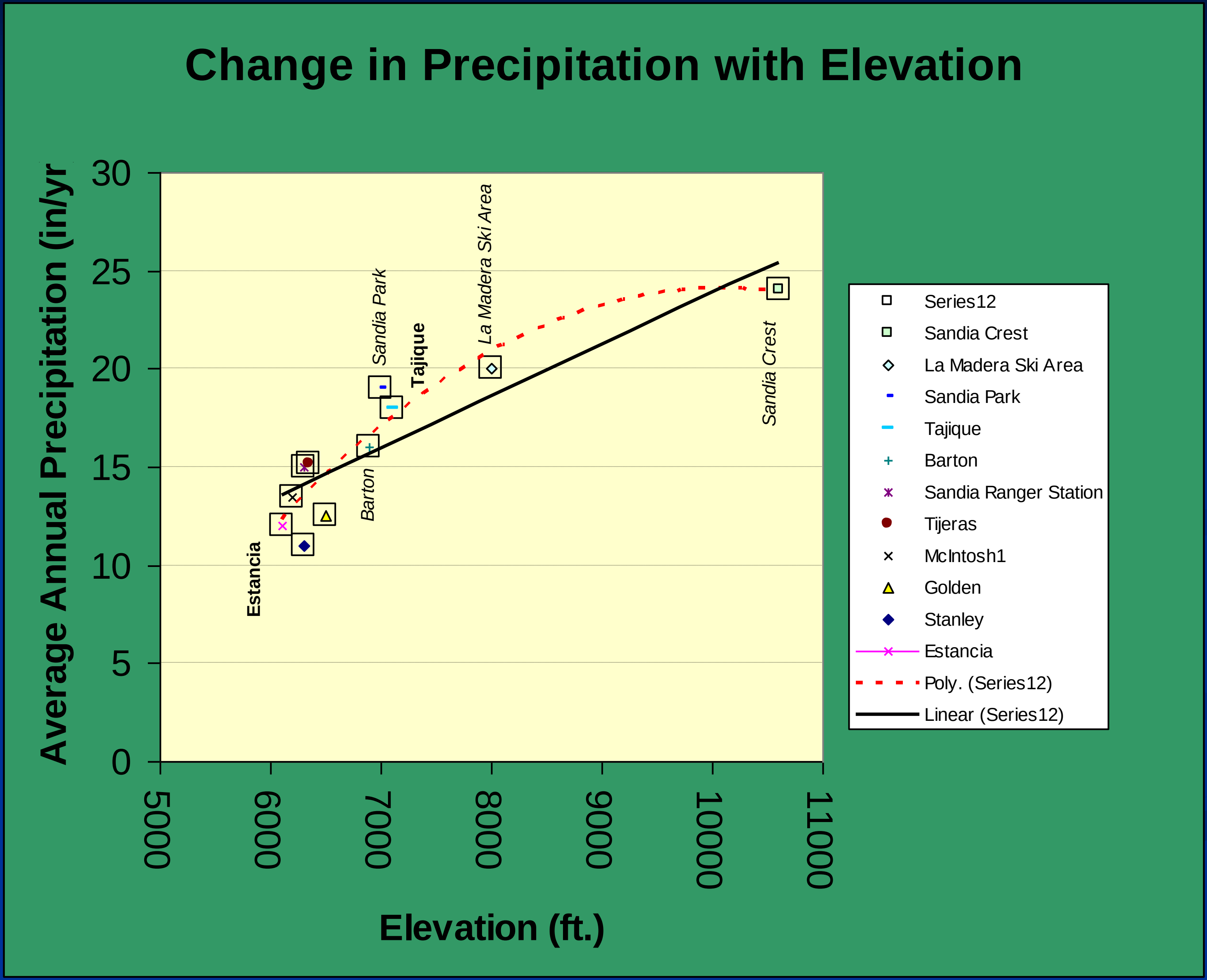
100 % - 80 % - 15% = 5%

Precipitation

- http://www.kayakwisconsin.net/uploaded_images/rain-o129-798294.jpg

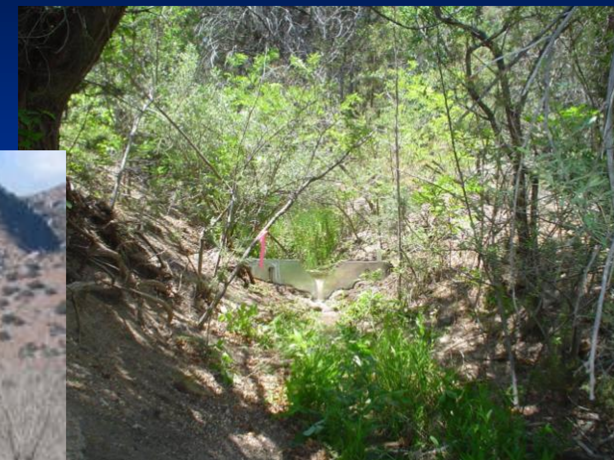
http://www.geofffox.com/MT/images/sleet-on-the-window.jpg

Variations in Precipitation



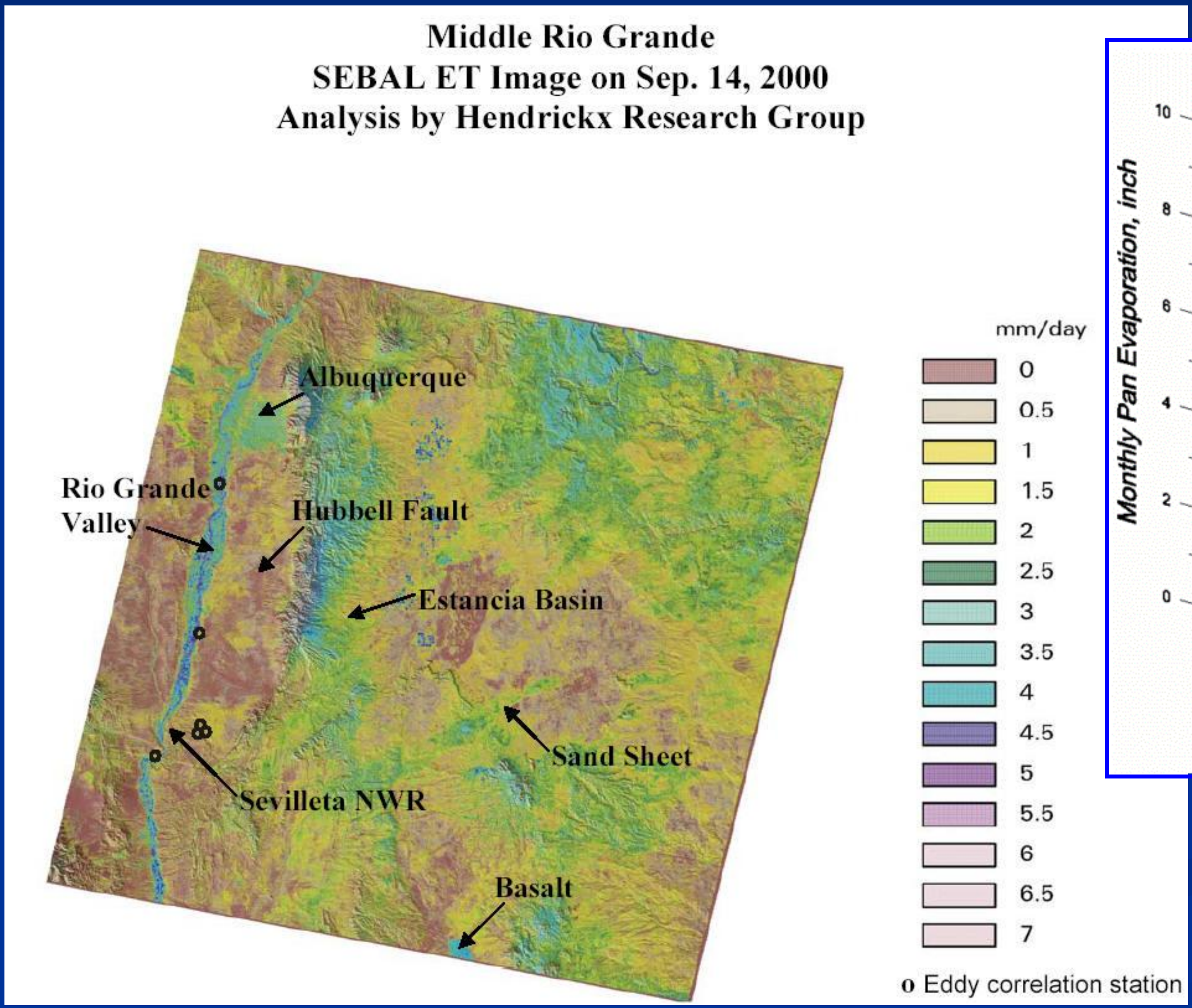
Evapotranspiraton

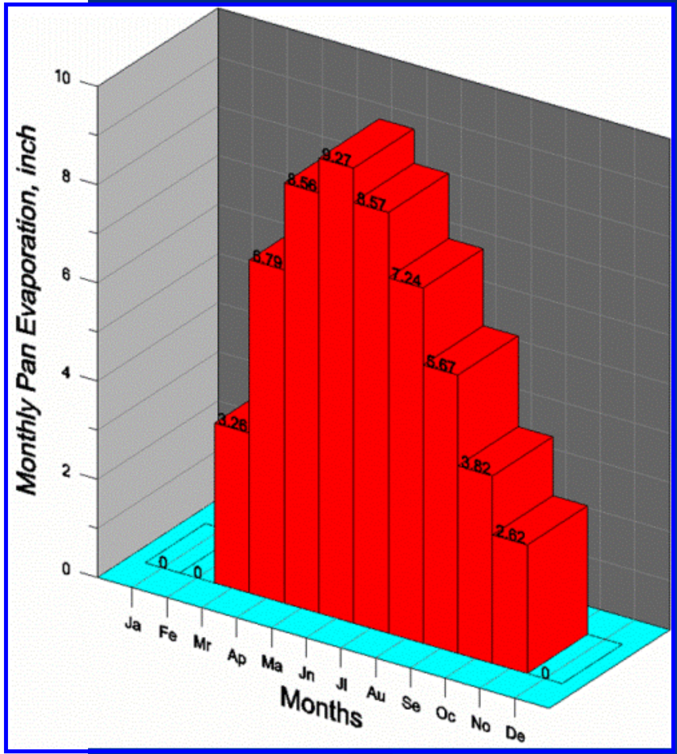
http://www.nmts.org/rides/tijerasTrot.htm



http://www.cabq.gov/openspace/images/bosquethumb.jpg

Variations in ET

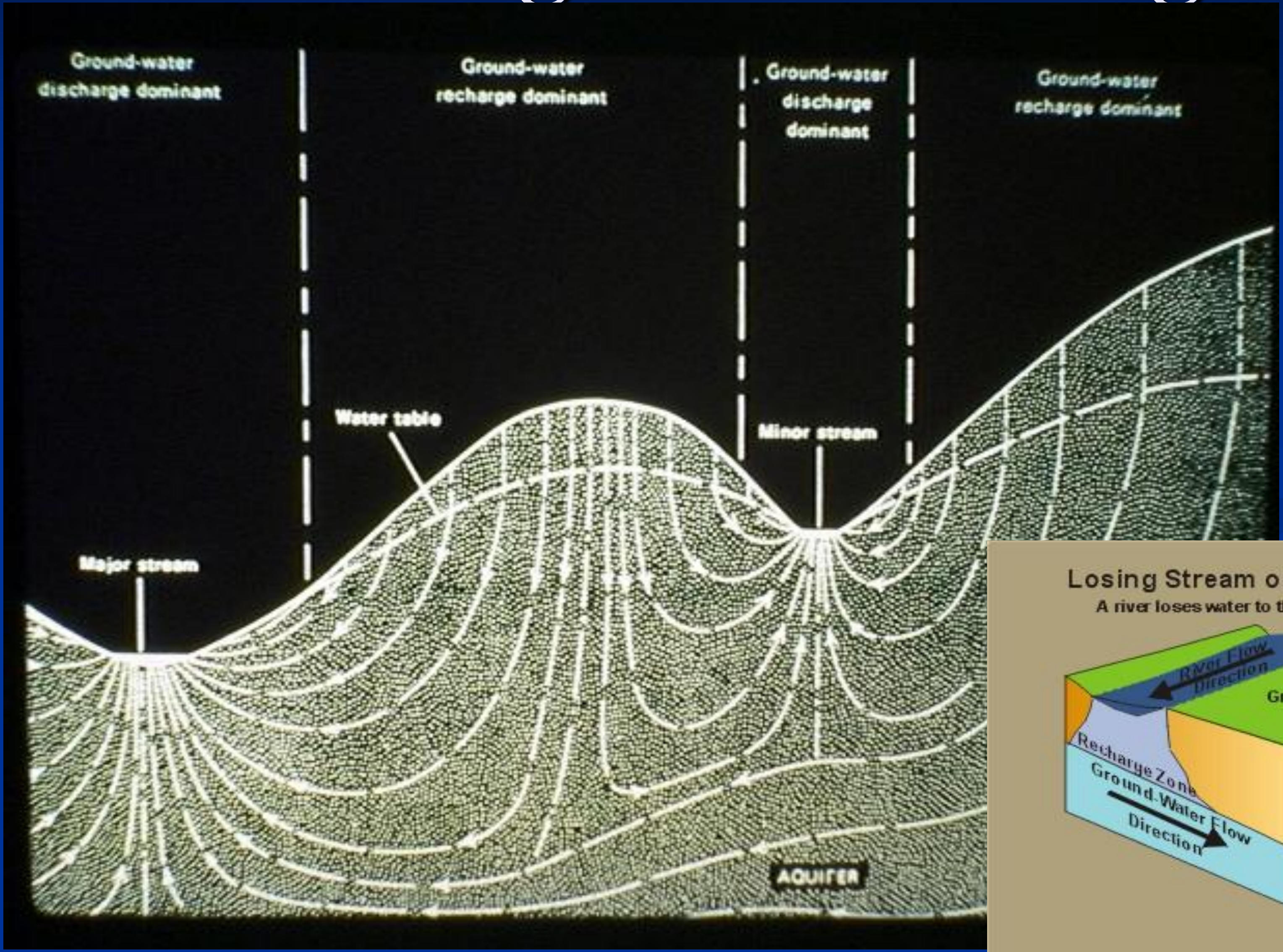


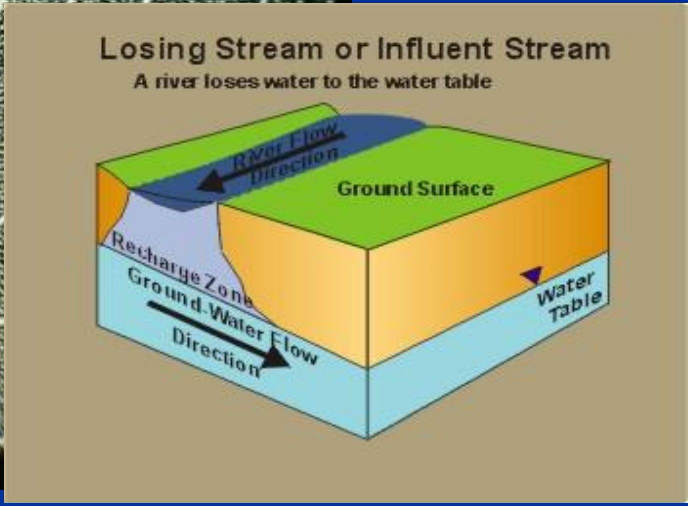


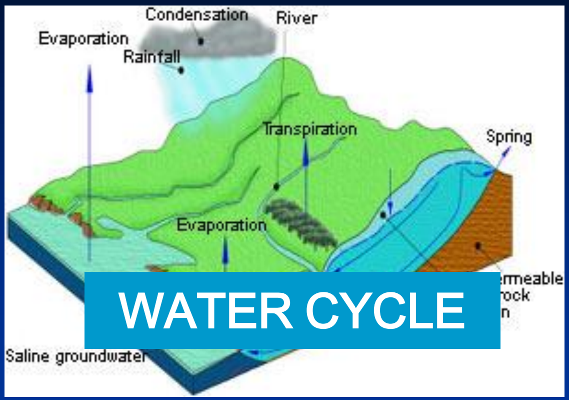
http://www.nmt.edu/~hong/research.html

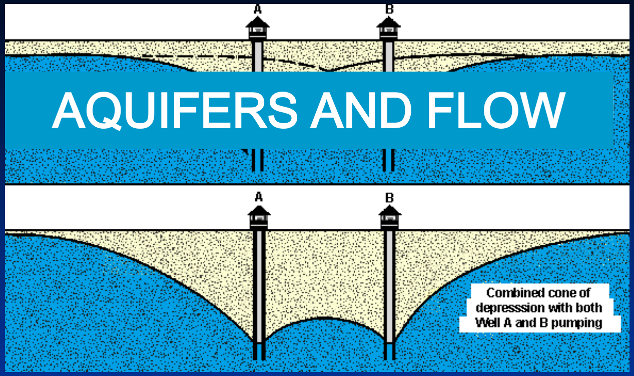
Streamflow

Recharge and Discharge









Groundwater & Wells

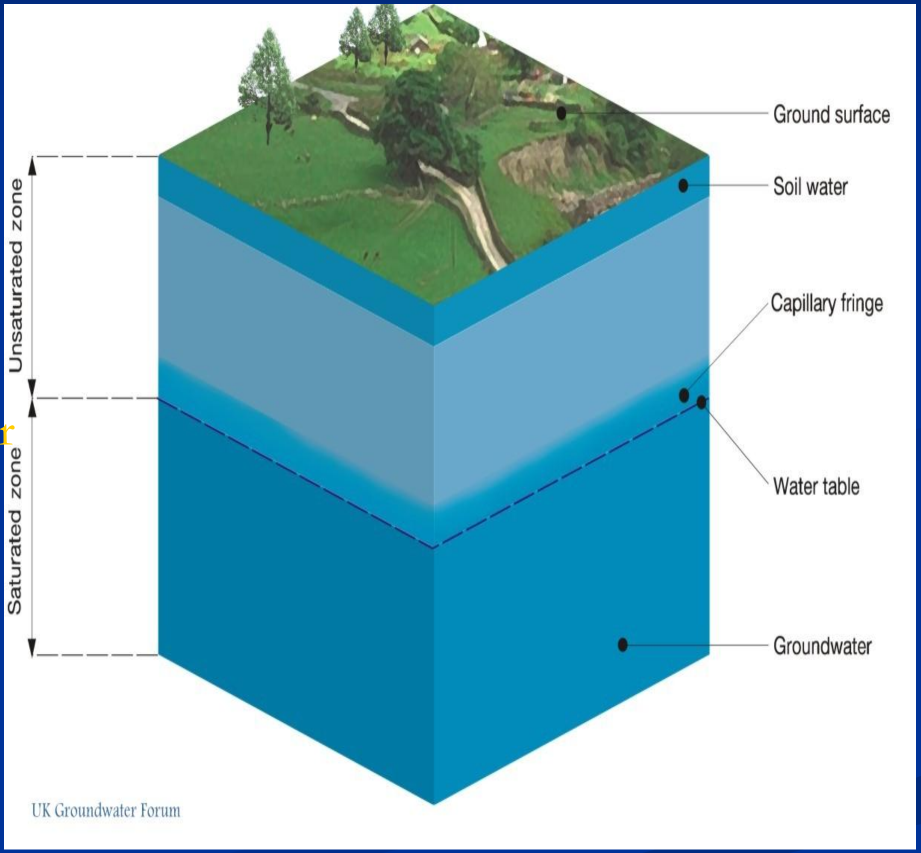
FUNDAMENTAL DEFINITIONS

Important Terms

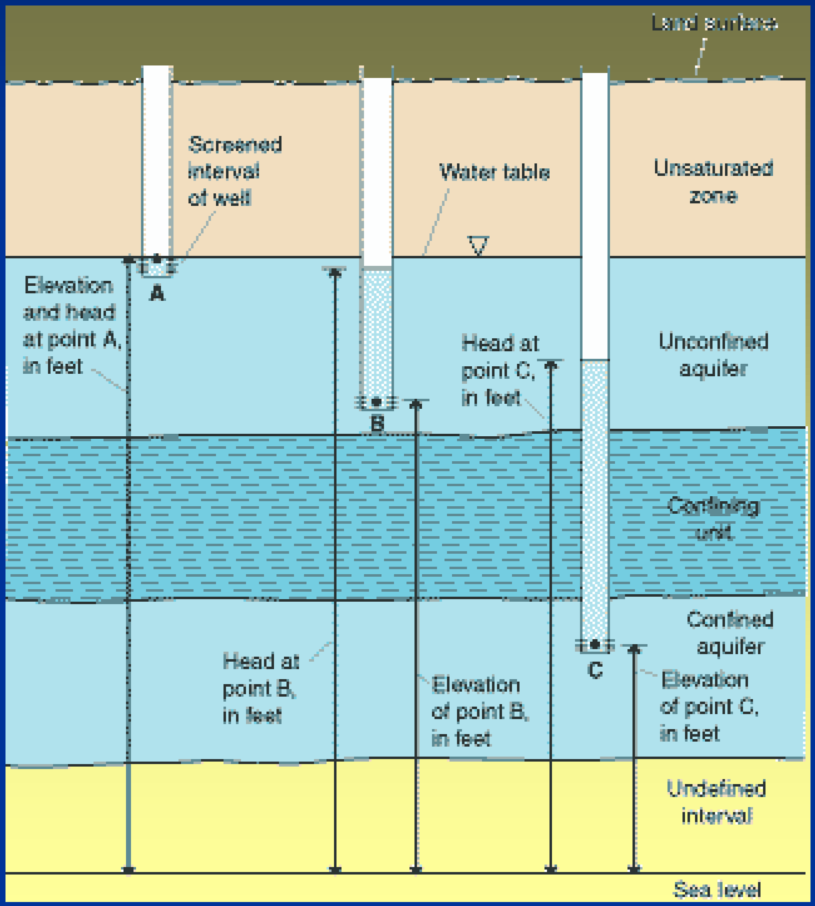
- Hydraulic Head
- Porosity
- Hydraulic Gradient
- Hydraulic Conductivity
- Transmissivity
- Specific Yield
- Storage Coefficient

Water Cycle - Definitions

- **Unsaturated Zone –** zone between the land surface and the saturated zone (also called the *zone of aeration* or *vadose zone*)
- **Capillary Fringe** – zone immediately above the water table , where water is drawn upward by capillary attraction
- **Water Table –** the surface at which pore water pressure is equal to atmospheric pressure
- **Saturated Zone –** zone in which voids in rock are filled with water
- **Aquifer** – formation or part of a formation which is saturated and can produce economic quantities of water



Groundwater Flow - Aquifers



Unconfined Aquifer – aquifer where the water table is exposed to the atmosphere through openings in the overlying material

Confining Unit – material of low hydraulic conductivity that is adjacent to an aquifer , it may be above, below or both

Confined Aquifer – aquifer wherein the groundwater is generally subject to pressure greater than atmospheric and is confined by relatively impermeabl or less permeable layers. The water table rises above the top of the aquifer.

Groundwater Flow - Artesian

Artesian – A well deriving its water from a confined aquifer - it may be flowing at the surface or the level may merely be above the confining bed and non-flowing.

GROUNDWATER FLOW

Darcy's Law

Henry Darcy, mid 1800 in Dijon experimented with water flow in tubes and filters of sand

Hydraulic Gradient (unconfined aquifer)

- difference in hydraulic head

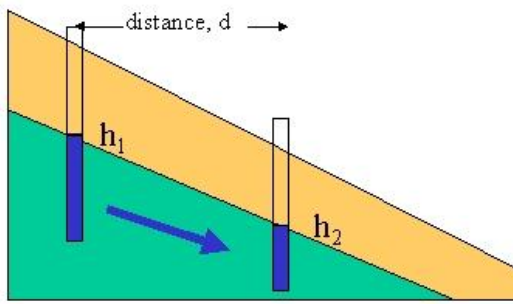
$$v \propto (h_1 - h_2)/d$$

- water flows faster through coarser material

$$v \propto K$$

- Darcy's Law

$$v = K(h_1 - h_2)/d$$

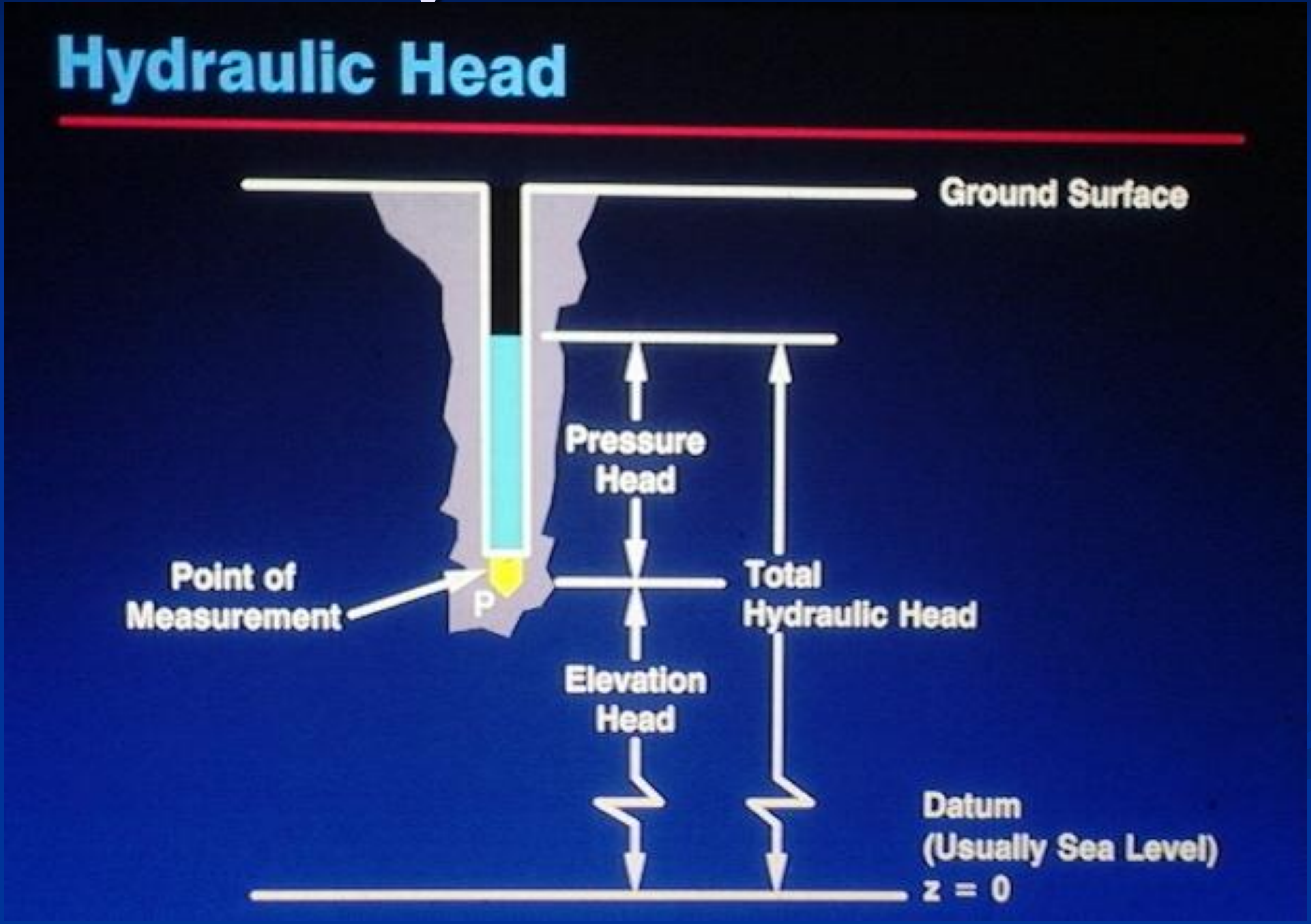


Gradient – The difference in head divided by the distance between measuring points, gradients can be horizontal, vertical, or some of both

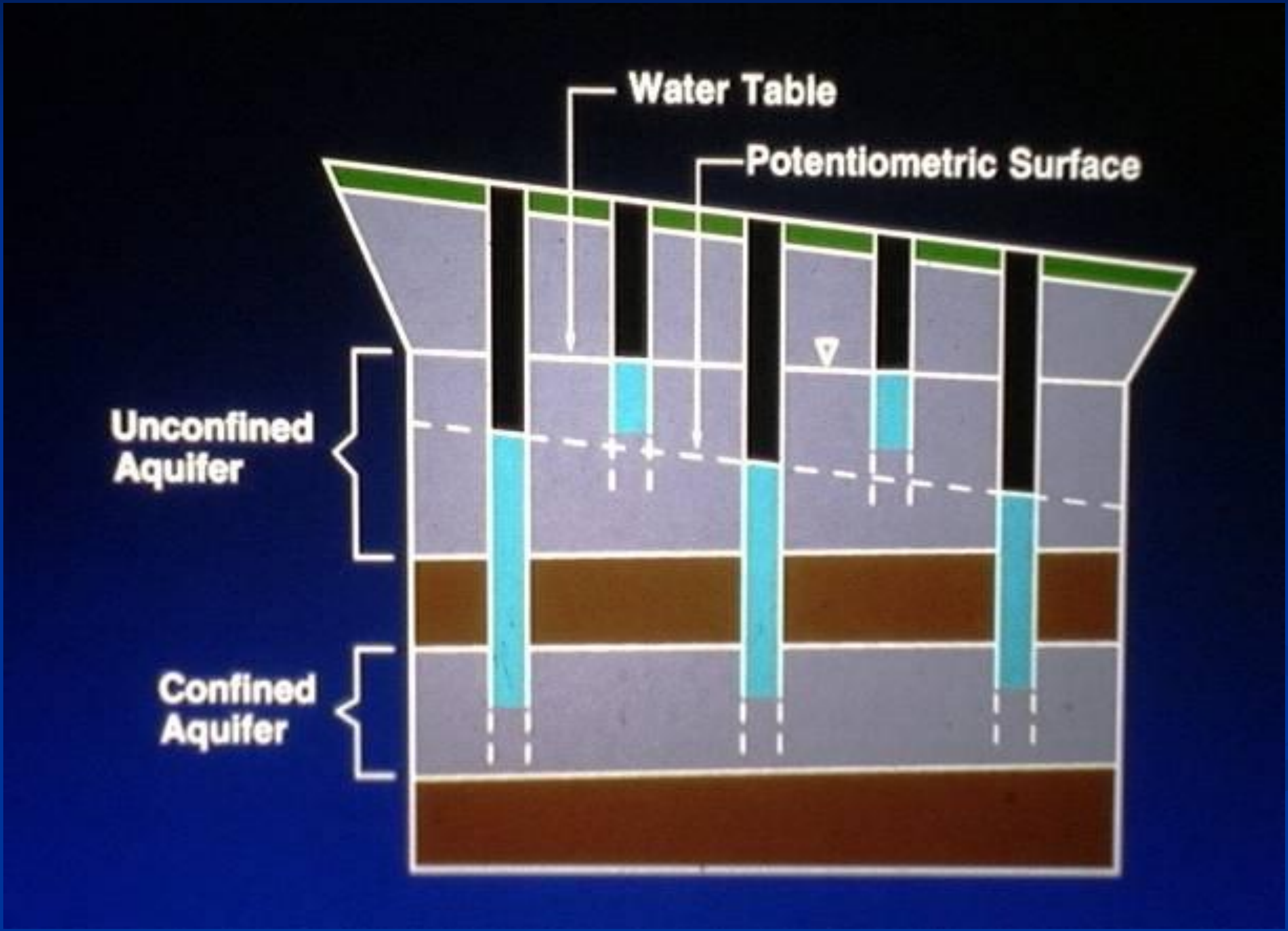
Hydraulic Conductivity (K) – A measure of the aquifers ability to transmit water. The rate of flow through a cross-section of one unit square under a unit of hydraulic gradient

Transmissivity (T) – the rate of flow through a unit width of aquifer (unit width x saturated thickness) under one unit of hydraulic gradient. (The hydraulic conductivity x the thickness of the aquifer)

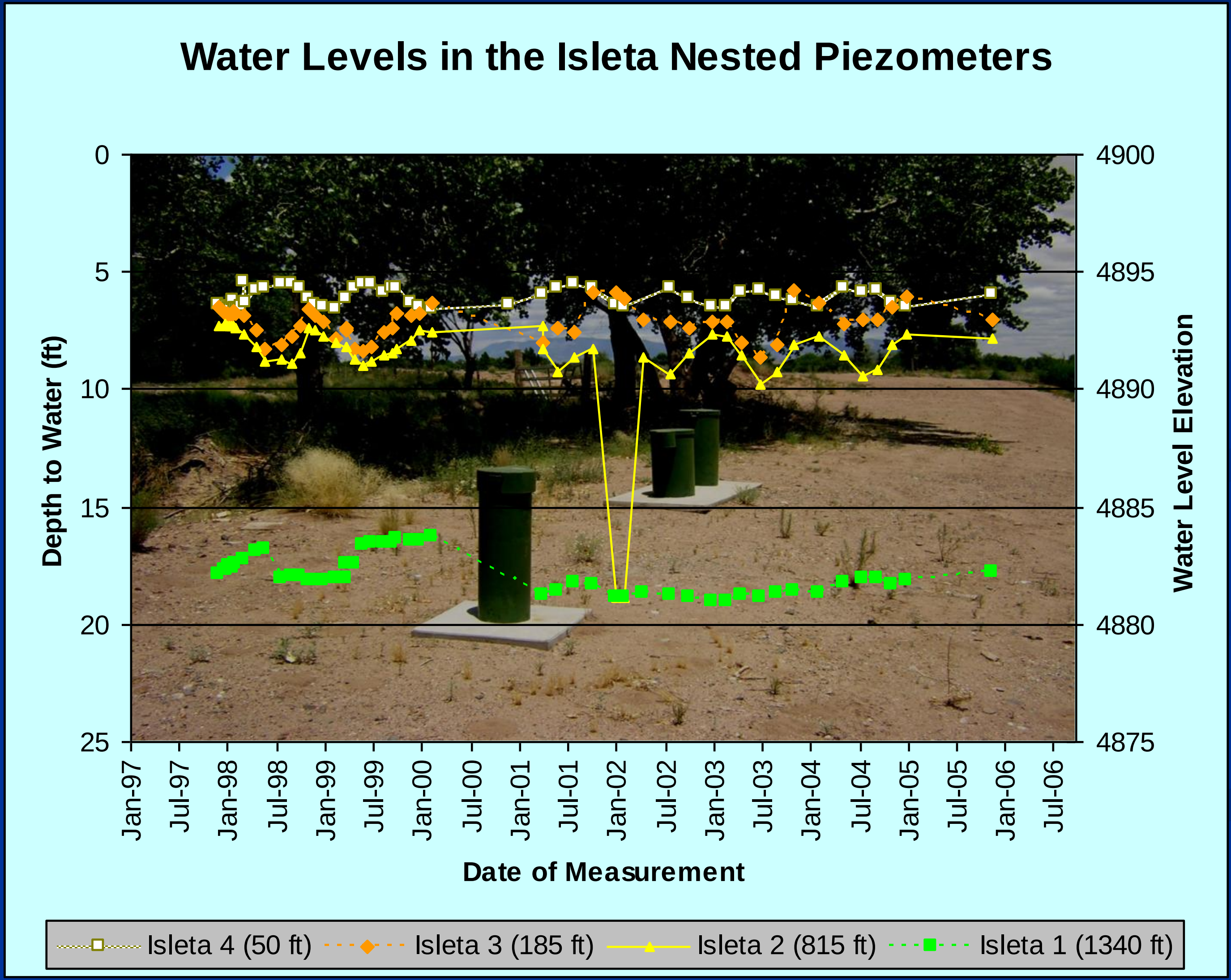
Hydraulic Head



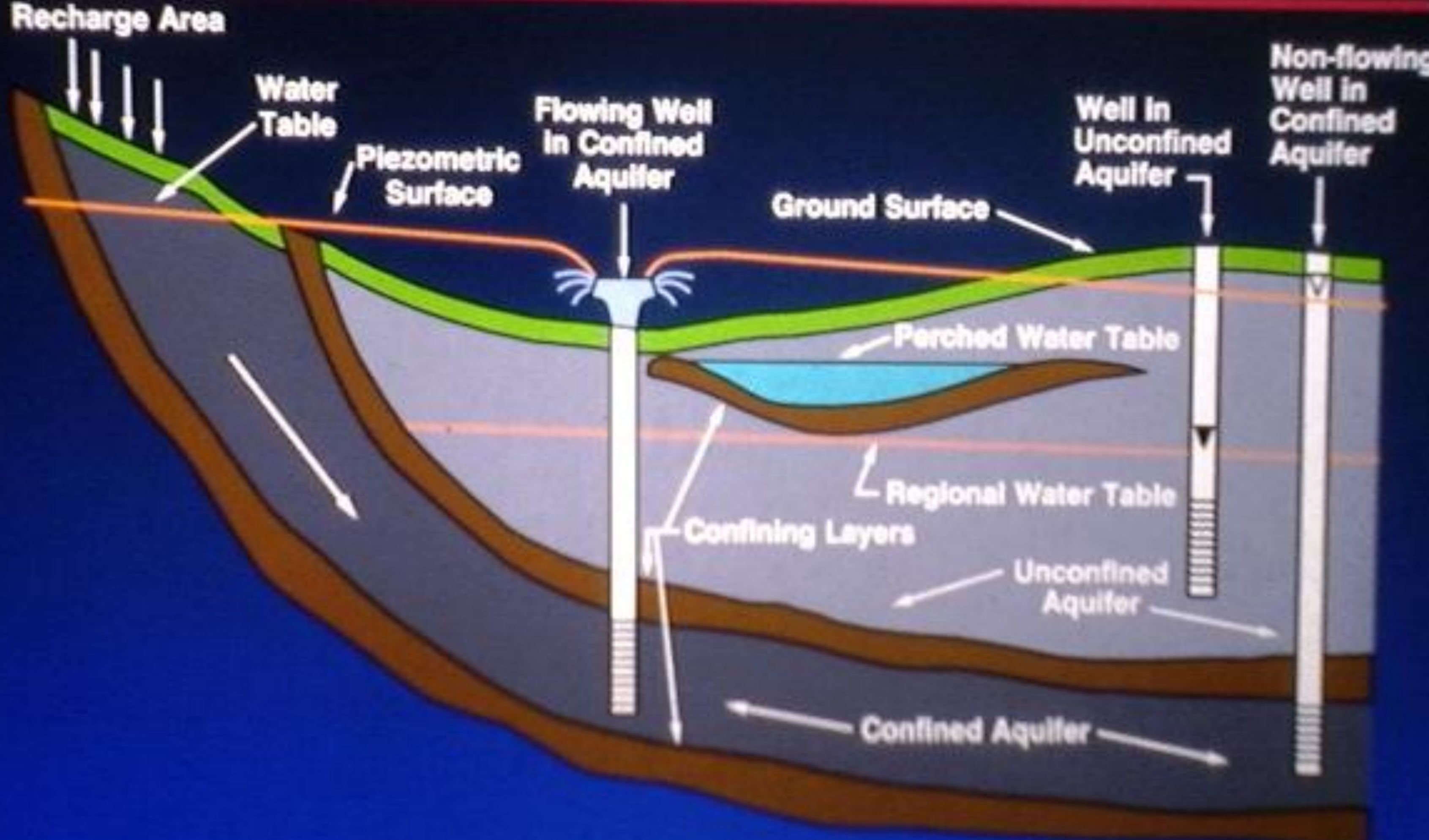
Water Levels and Gradients



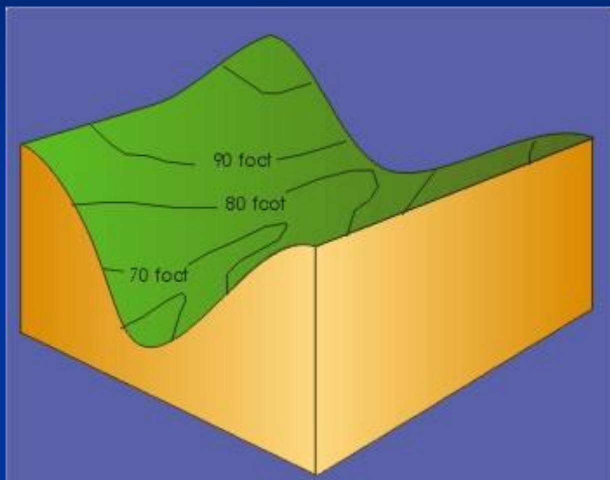
Hydraulic Heads within an Unconfined Aquifer Through Time

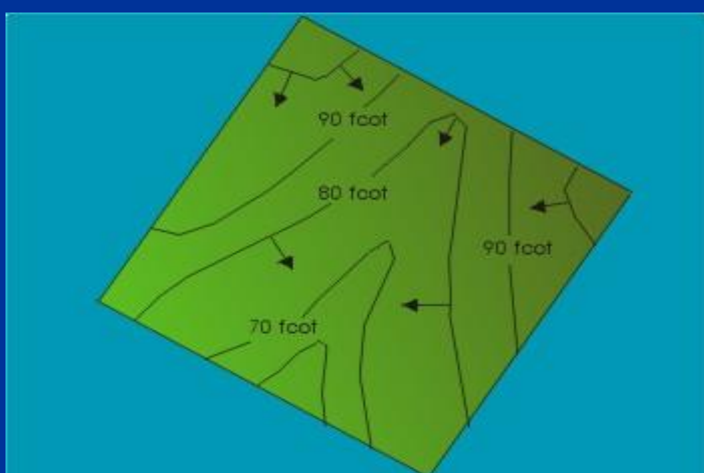


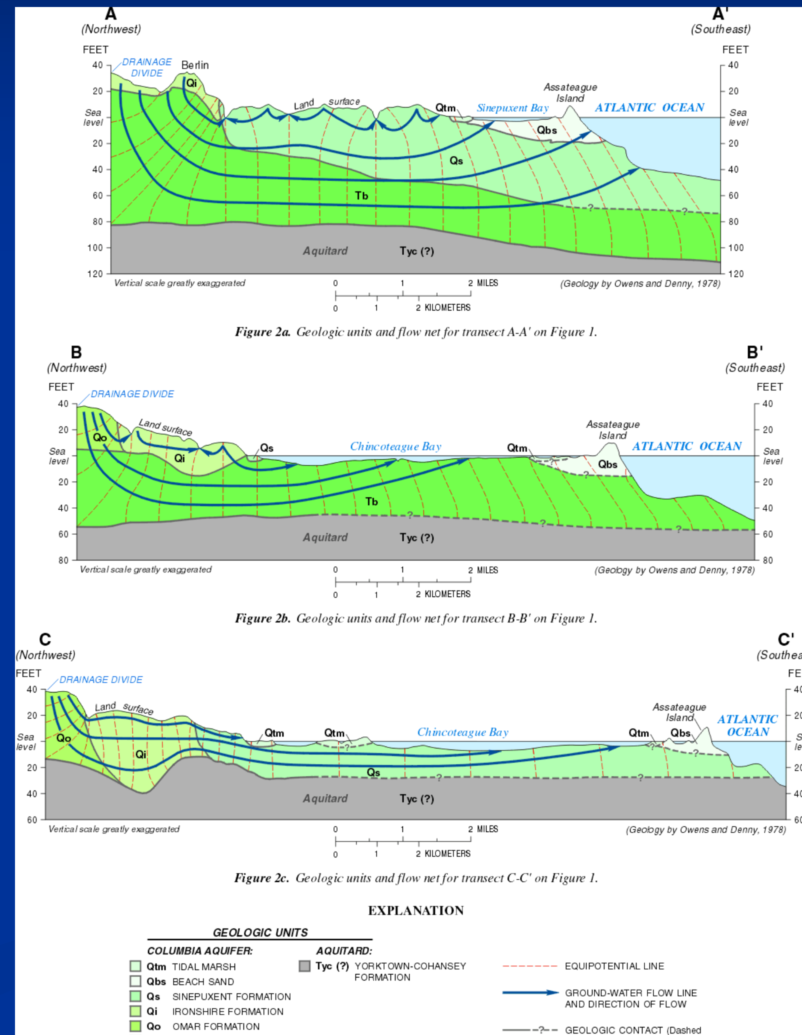
Head Measurement in Different Types of Aquifers



Groundwater Flow - Head

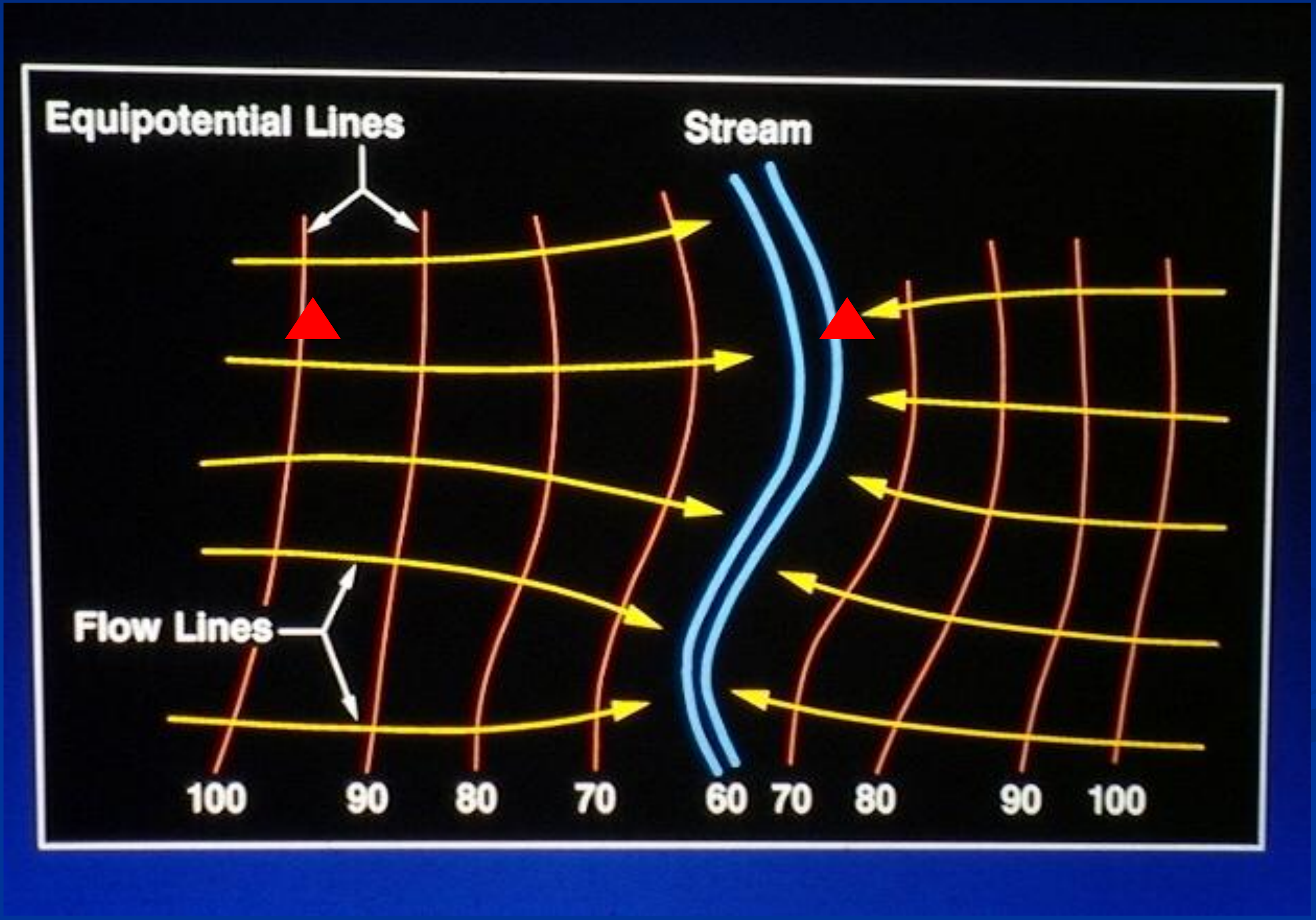






Groundwater Flow – Gradient

If the distance from A to B is 4,000 ft , then the horizontal gradient = ???
If A is screened at 40 feet and the river is at 0 feet, then the vertical gradient = ???



GROUNDWATER FLOW

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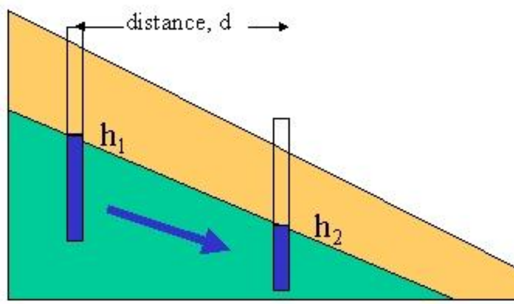
- Darcy's Law

$$v = K(h_1 - h_2)/d$$

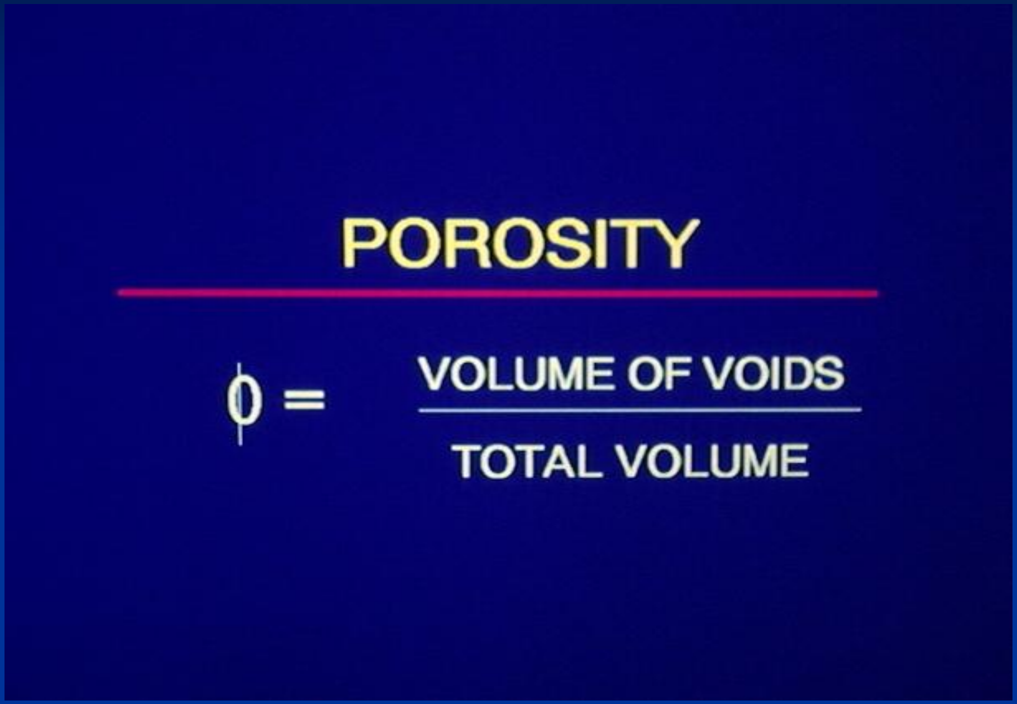


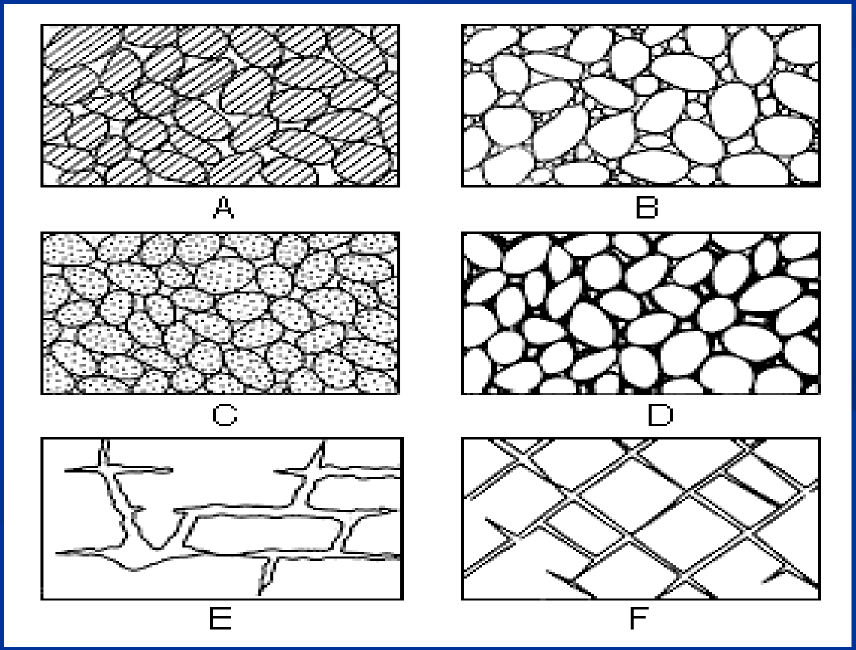
Gradient – The difference in head divided by the distance between measuring points, gradients can be horizontal, vertical, or some of both

Hydraulic Conductivity (K) – the rate of flow through a cross-section of one unit square under a unit of hydraulic gradient

Transmissivity (T) – the rate of flow through a unit width of aquifer (unit width x saturated thickness) under one unit of hydraulic gradient

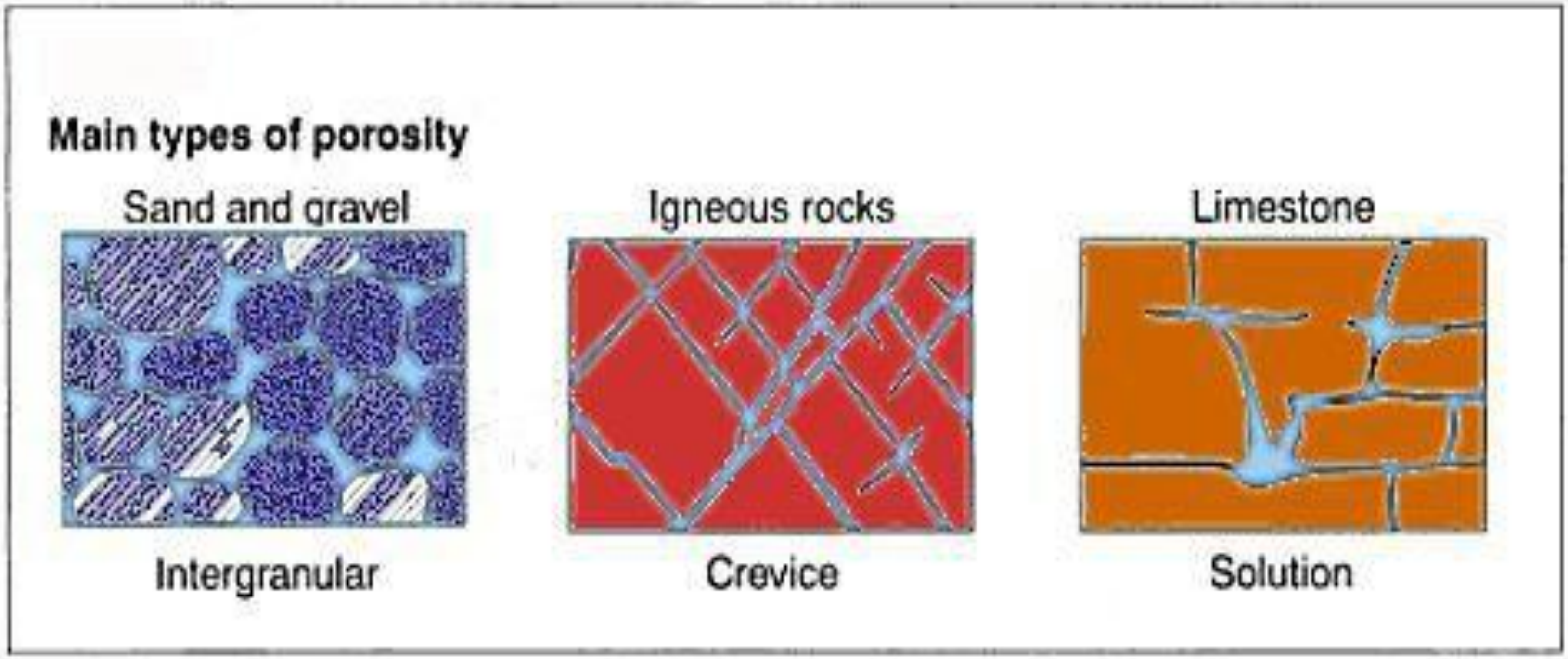
Porosity





www.kgs.ku.edu/General/Geology/Ford/gifs/fig5.gif

Groundwater Flow - Properties



Where groundwater can be found. It fills the spaces between sand grains, in rock crevices, and in solution openings.

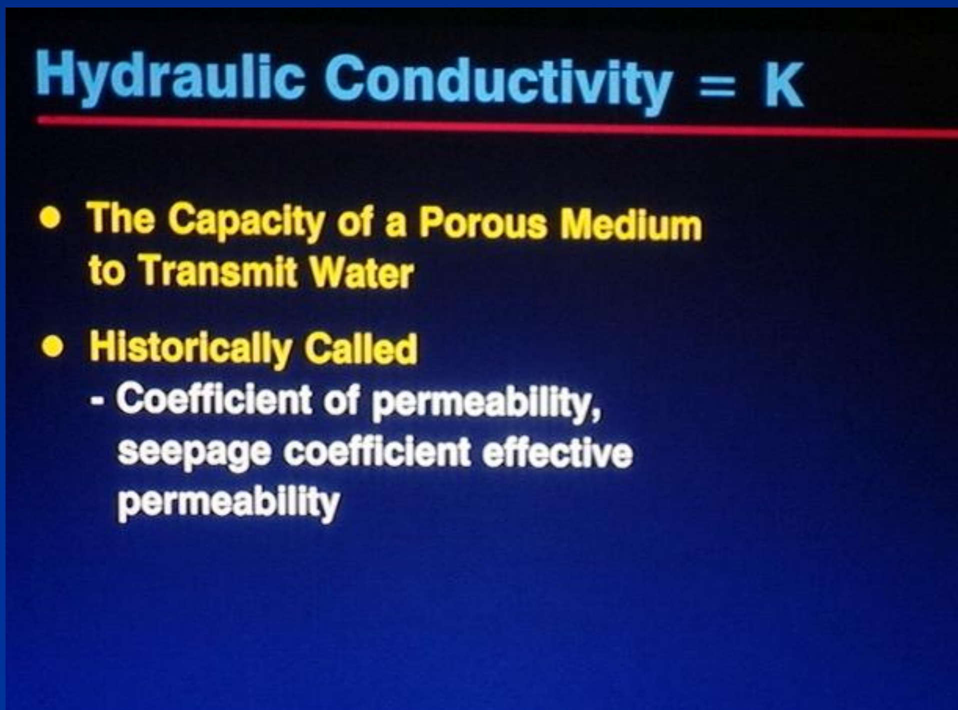
Range of Porosity Values

Gravel	25-40 %
Sand	25-50 %
Silt	35-50 %
Clay	40-70 %
Karst Limestone	5-50 %
Fractured Basalt	5-50 %
Fractured Crystalline Rock	0-10 %
Dense Crystalline Rock	0-5 %

(from Freeze and Cherry p. 37)

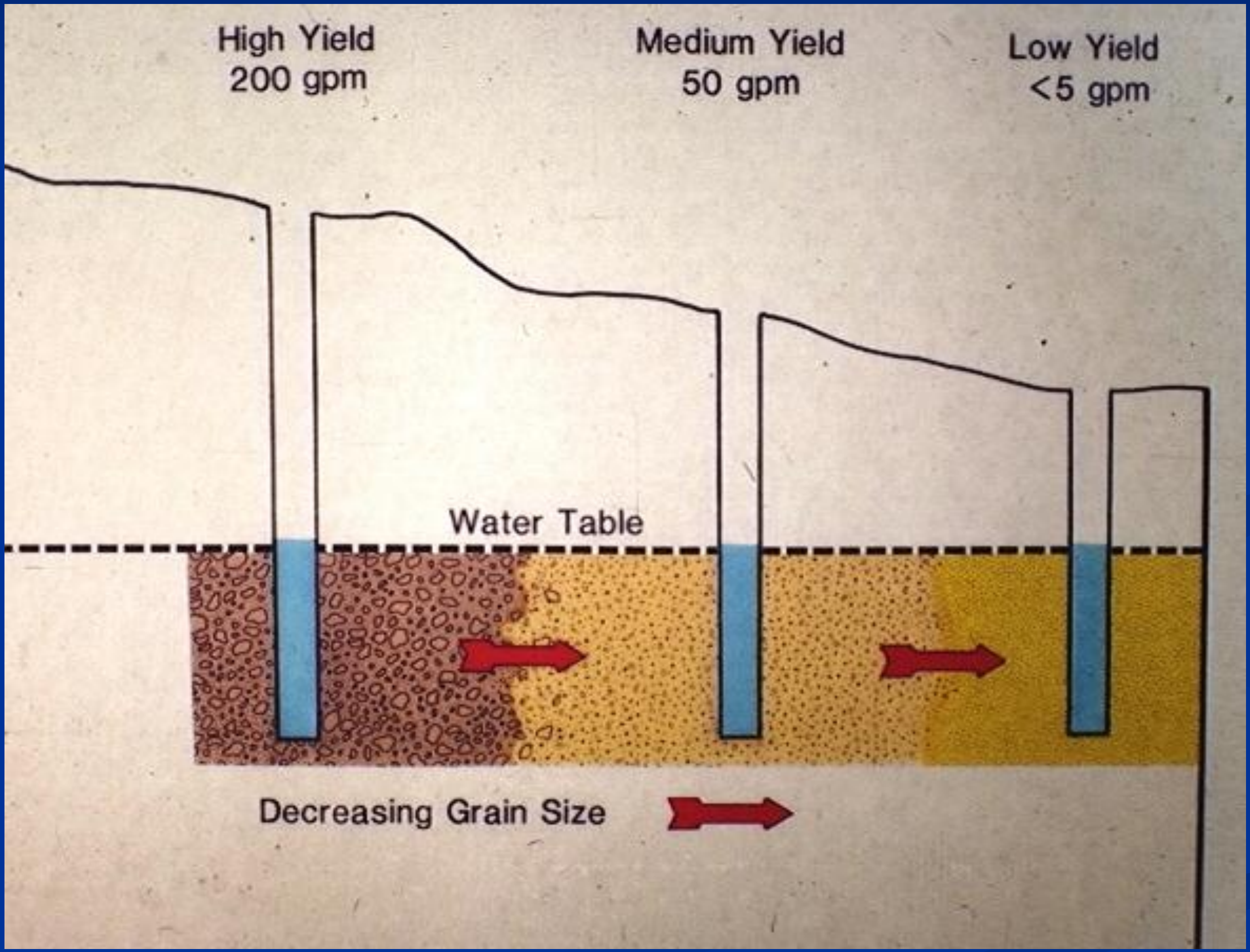
Porosity or Hydraulic Conductivity?

Hydraulic Conductivity



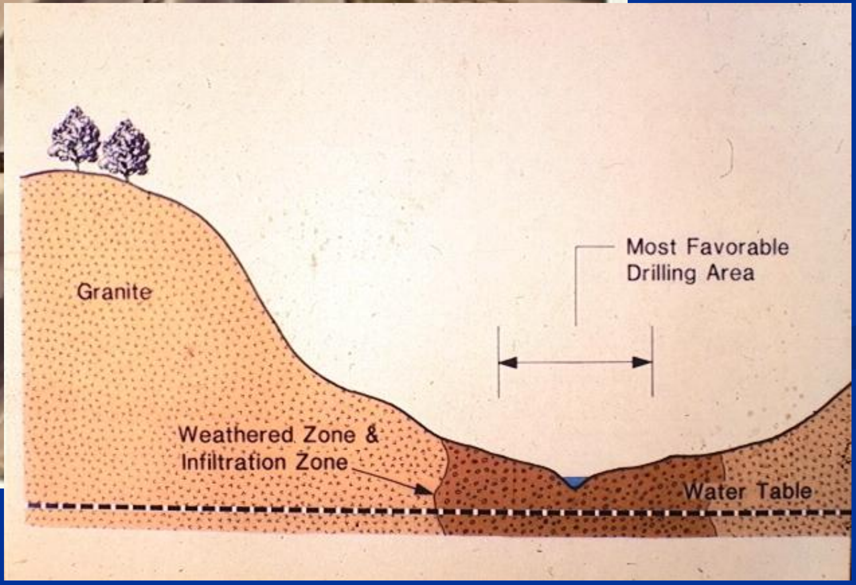
Sandstones and Clastics

Depositional Trends



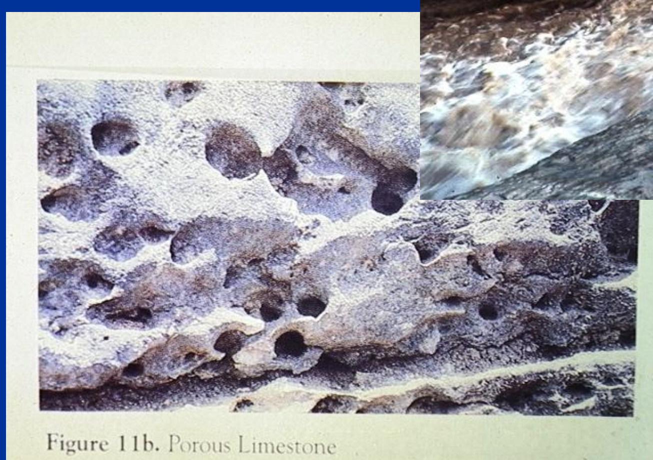
Volcanics and Igneous

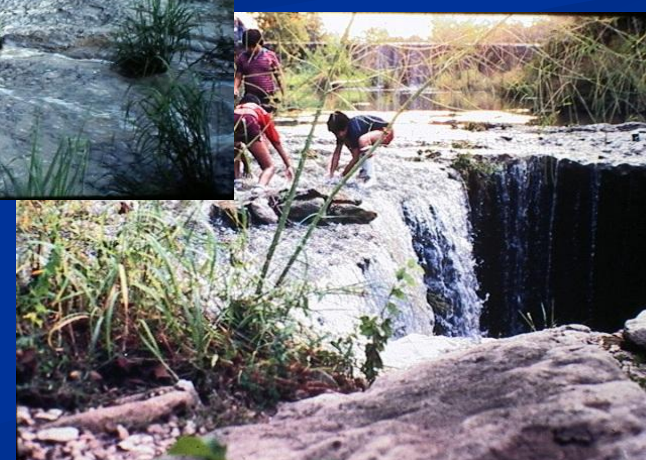
Tijeras Canyon



Limestone Formations

Karst Features





Groundwater Flow – Hydraulic Conductivity

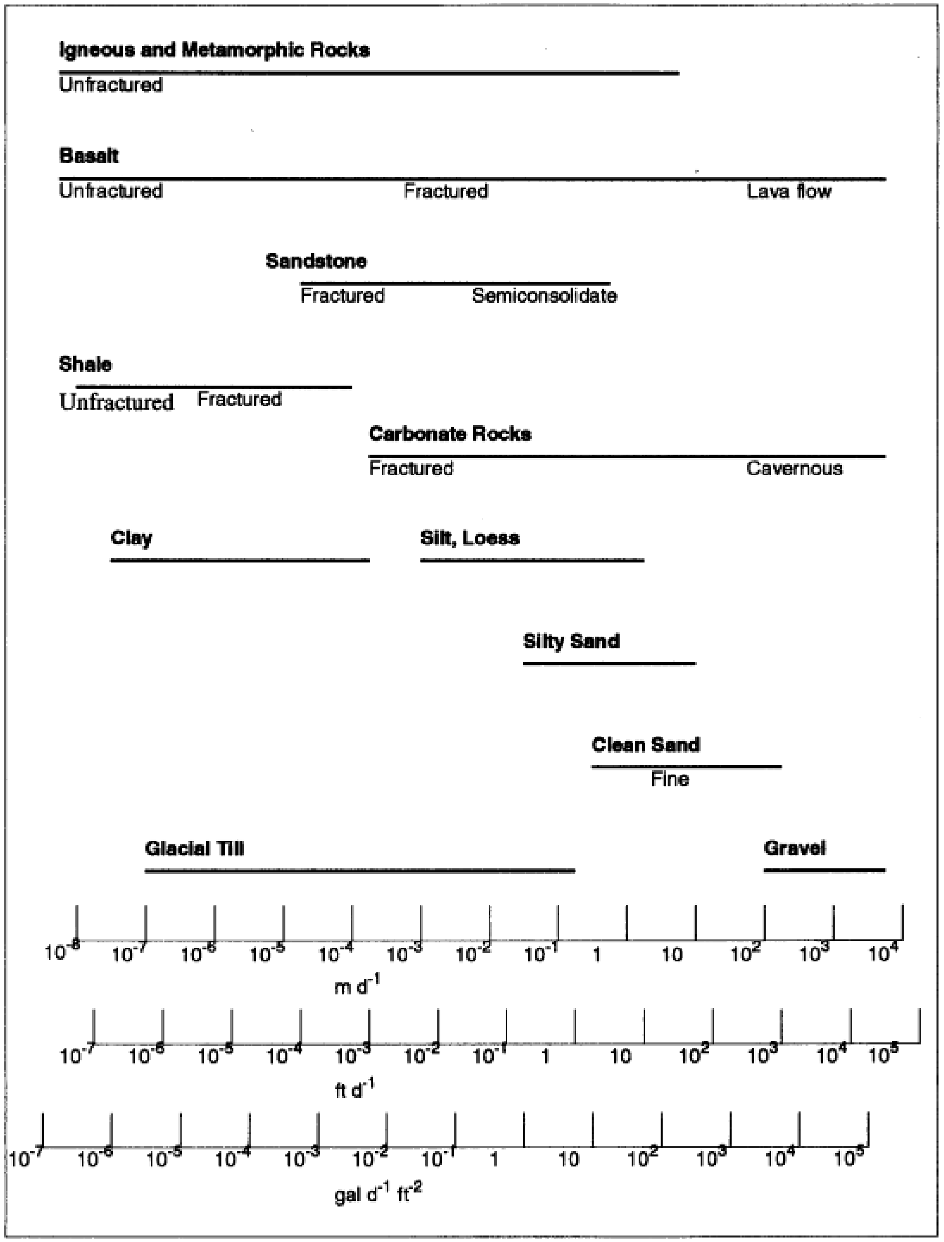
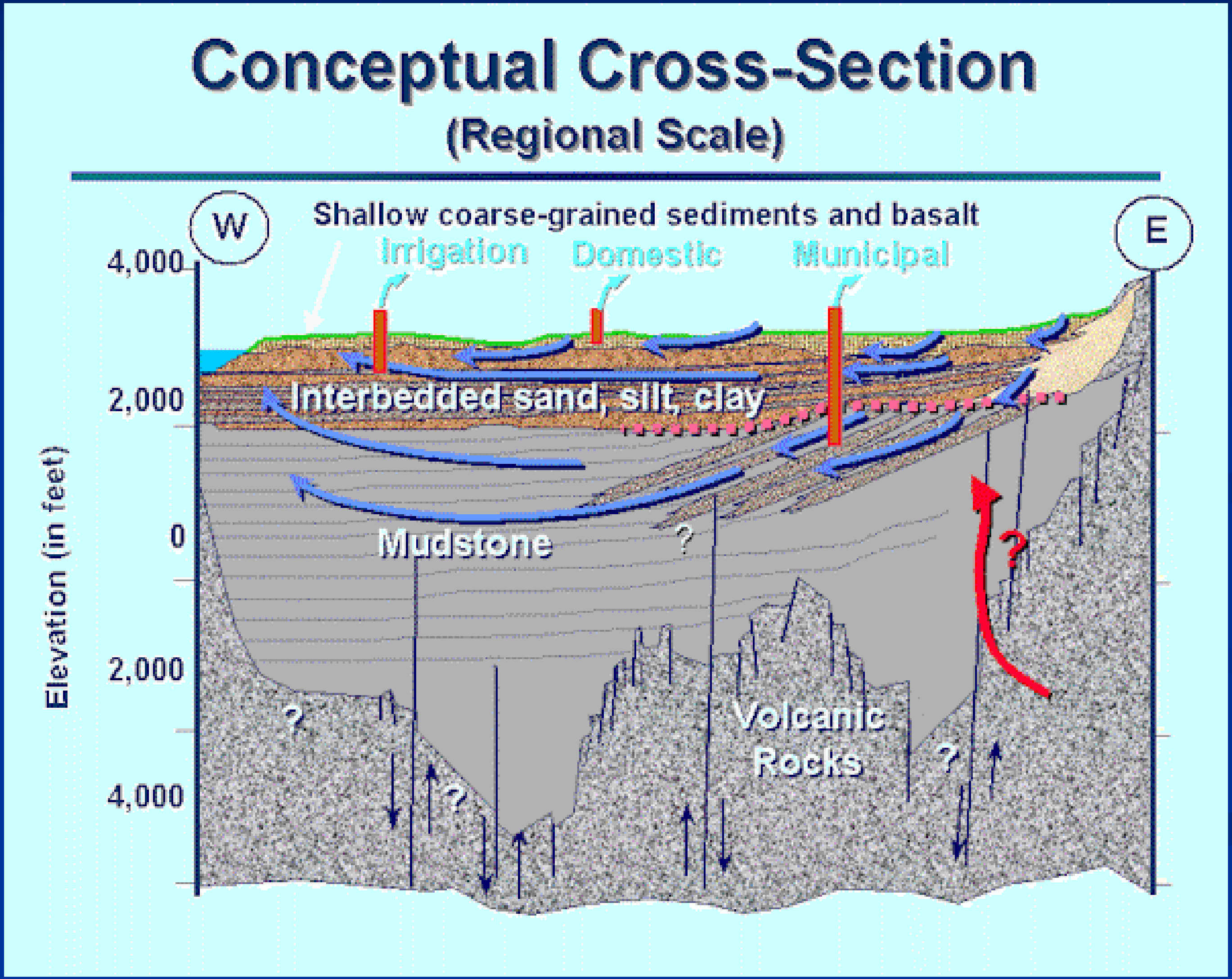


Figure 2-7. Hydraulic conductivity of rocks and soil

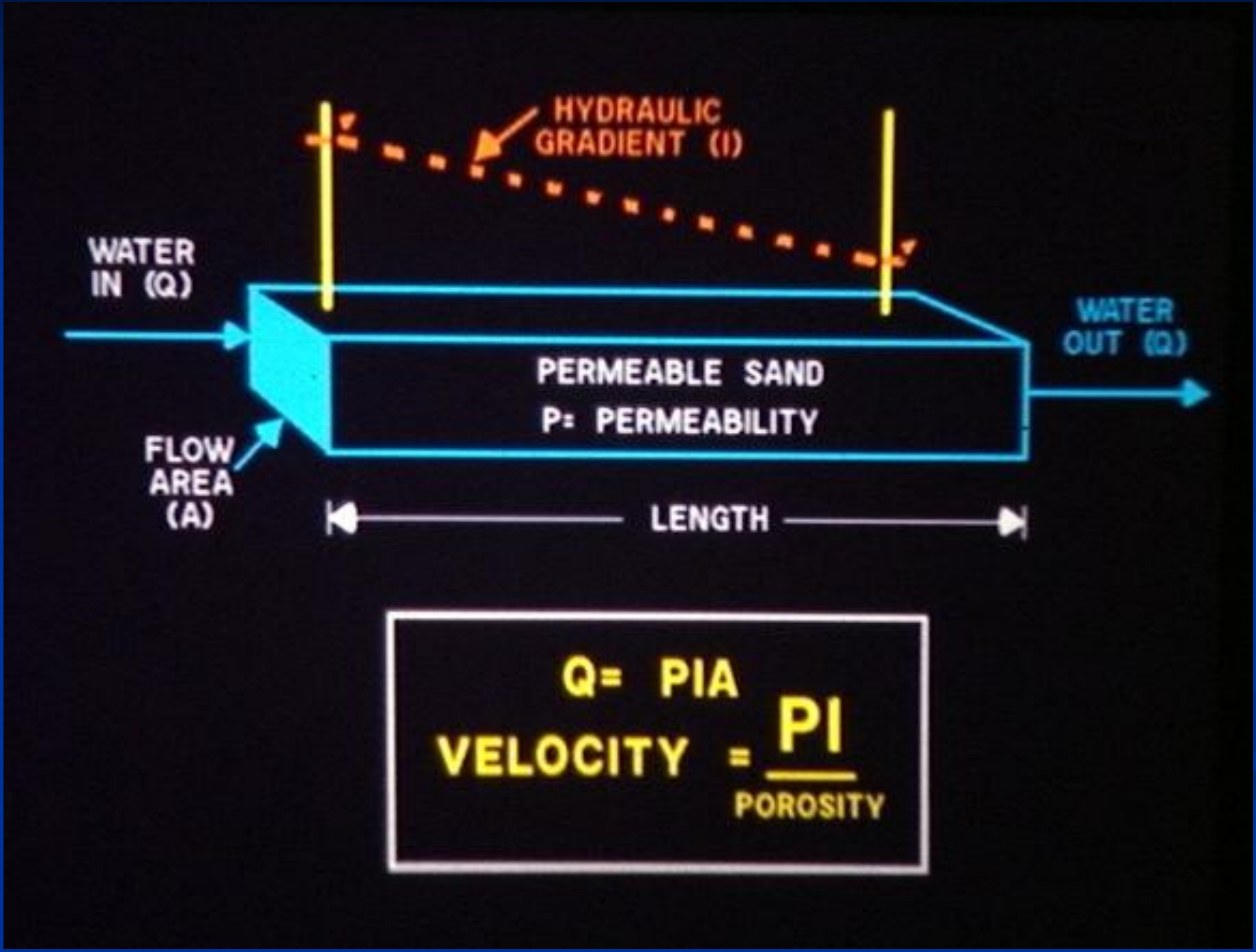
Geologic Complexities Prevail

Groundwater Flow – Flow Systems

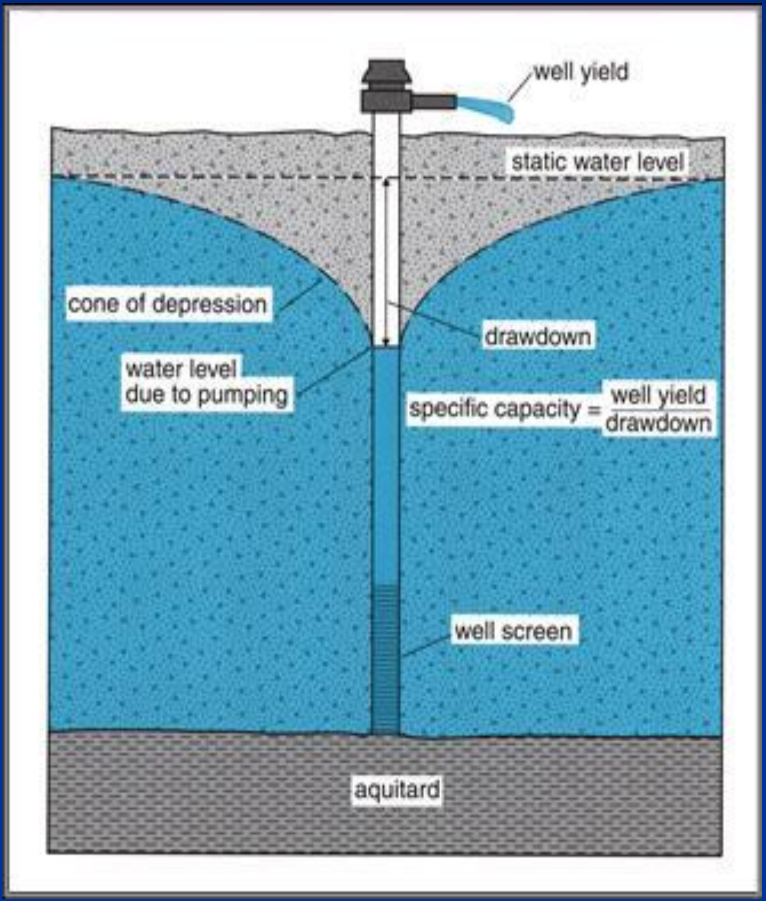


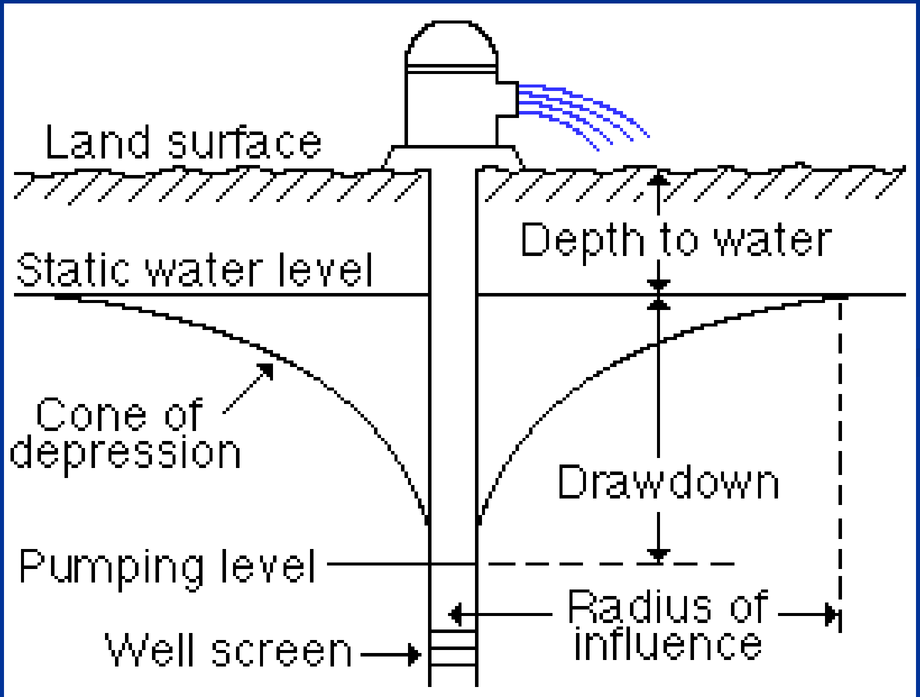
WELL HYDRAULICS

Well Hydraulics – Darcy's Law

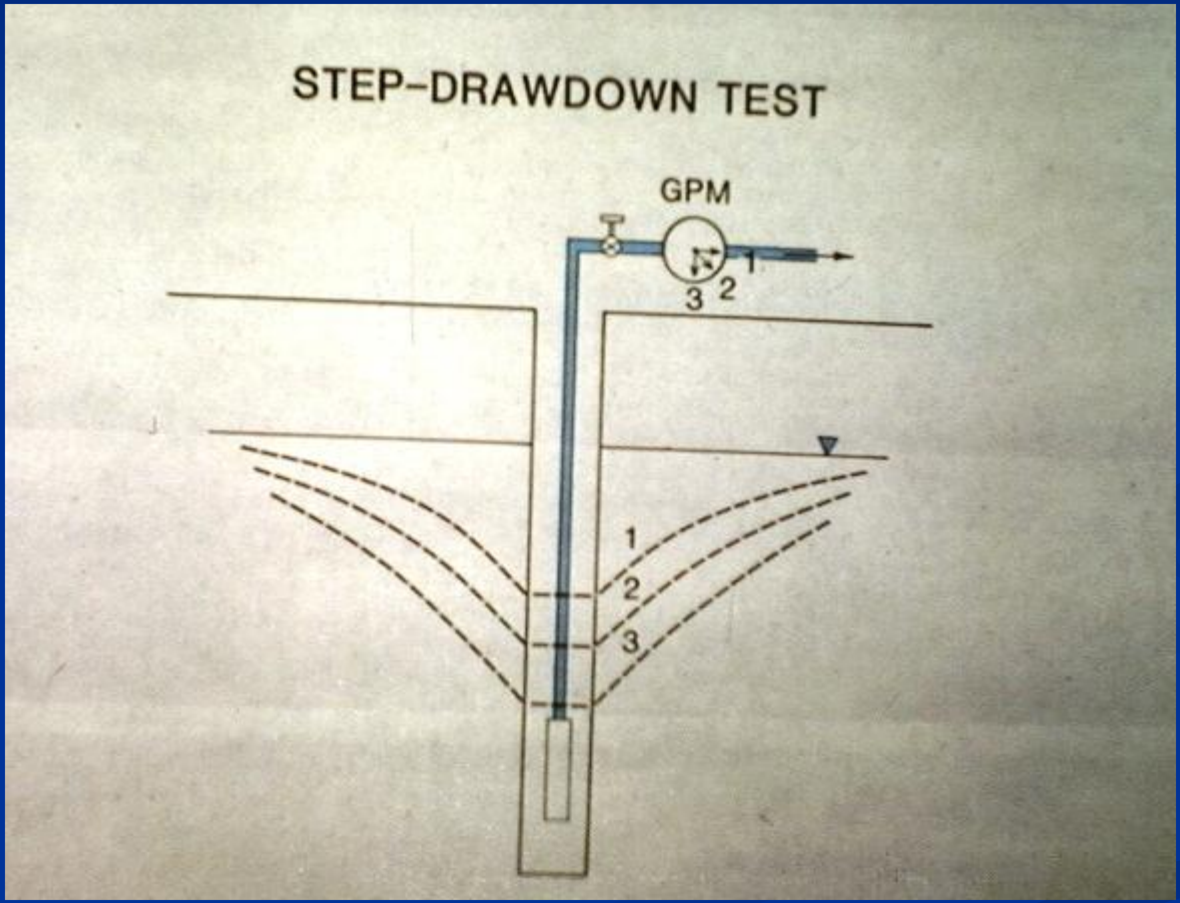


Well Hydraulics - Definitions





Well Hydraulics – Specific Capacity



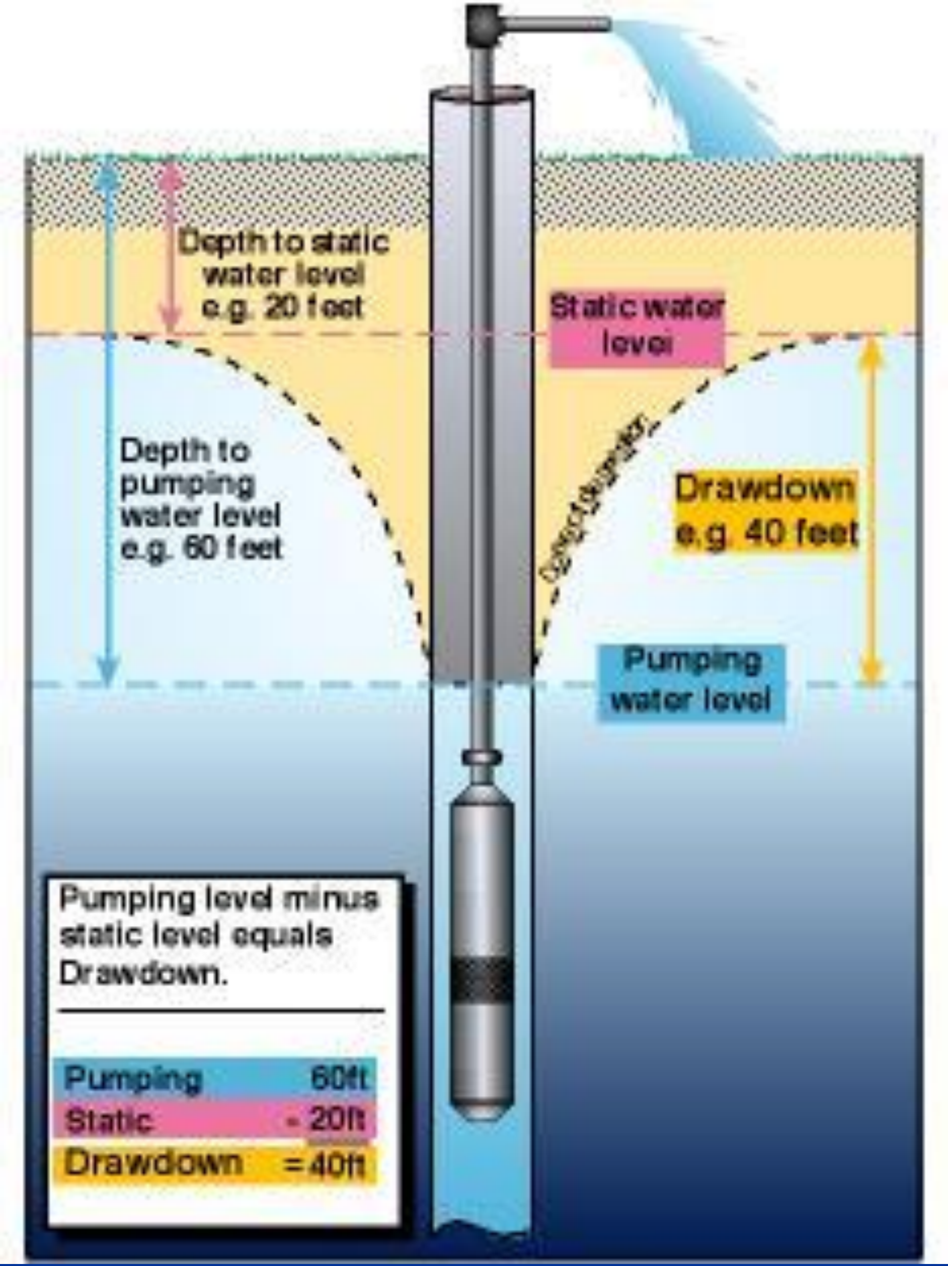
Well Hydraulics – Drawdown and Specific Capacity

Specific Capacity =

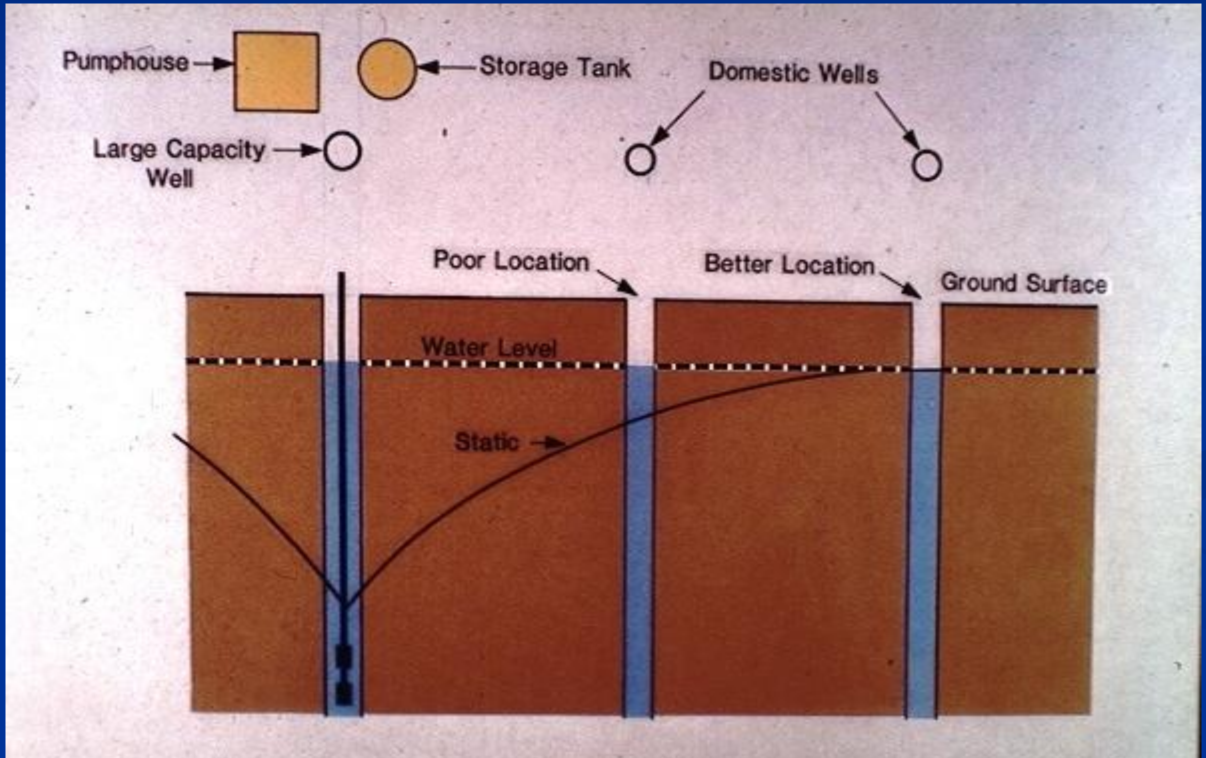
$$\frac{\text{Pumping Rate}}{(\text{Static Level} - \text{Pumping Level})}$$

- **Example:** Assume Q = 80 gpm
- Sp. Cap. = 80 gpm / (SWL – PWL)
- Sp. Cap. = 80 gpm / 40 ft
  = 2 gpm/ft

What would be the drawdown at 160 gpm ?

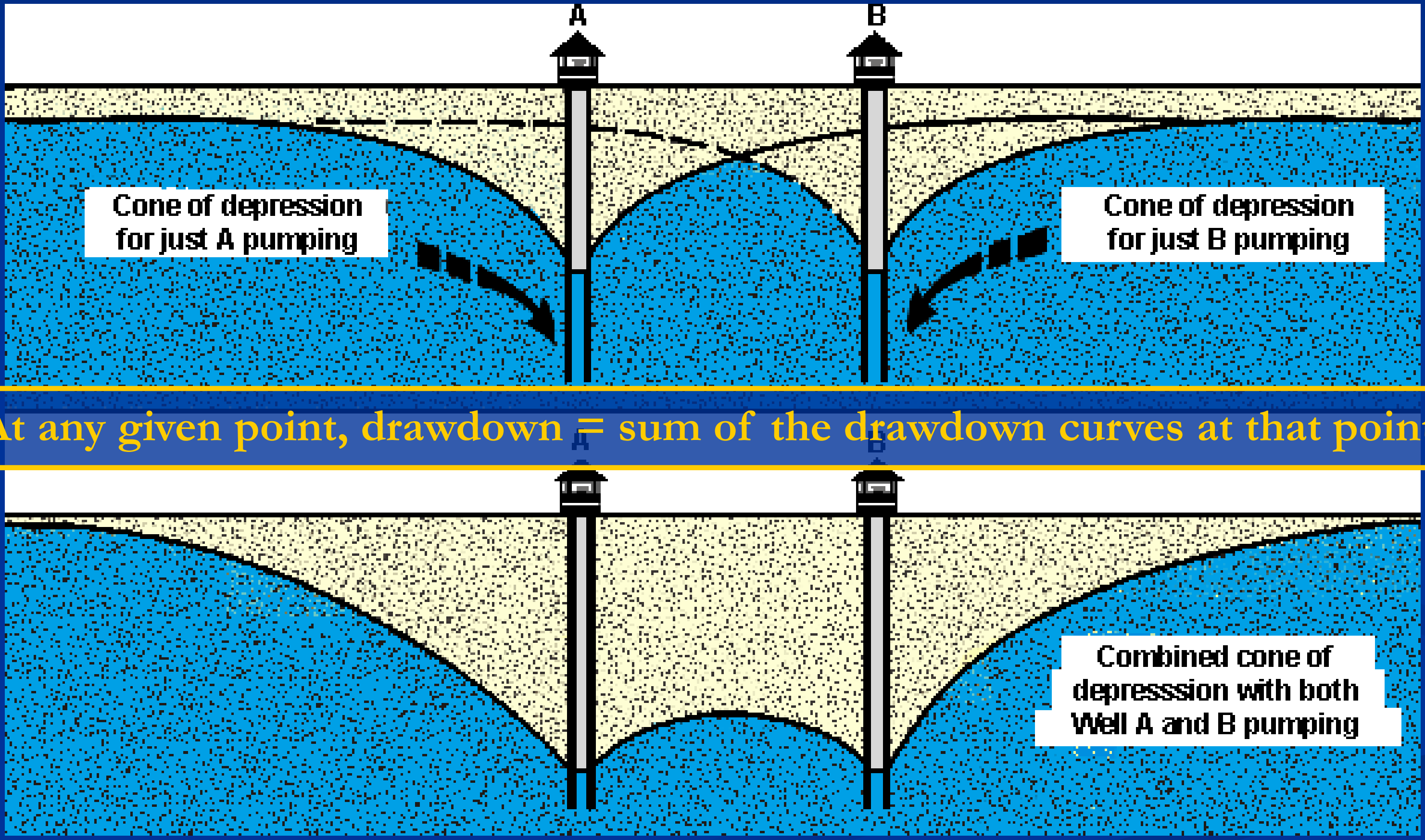


Well Hydraulics – Pumping Effects



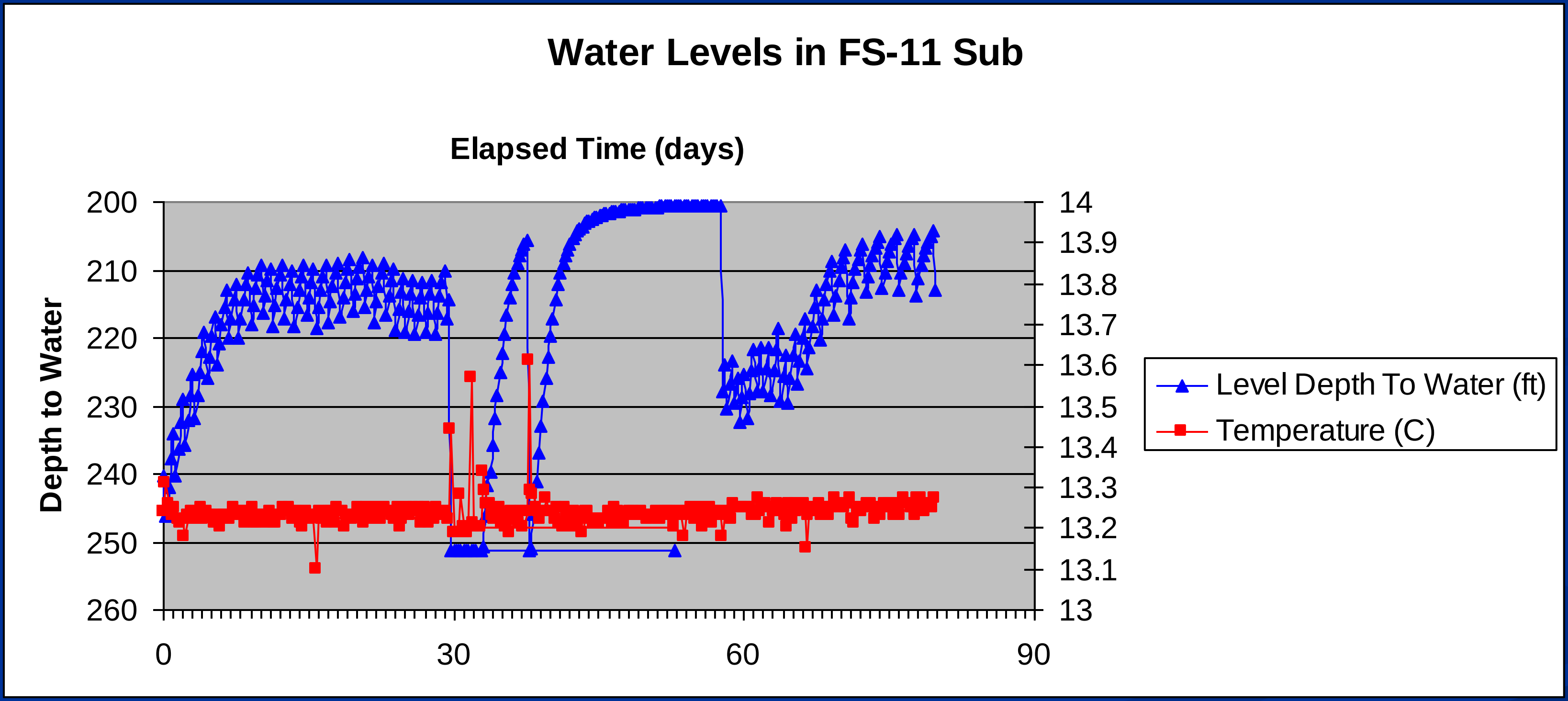
Influence of Near by Pumping Well

Groundwater Flow - Interference

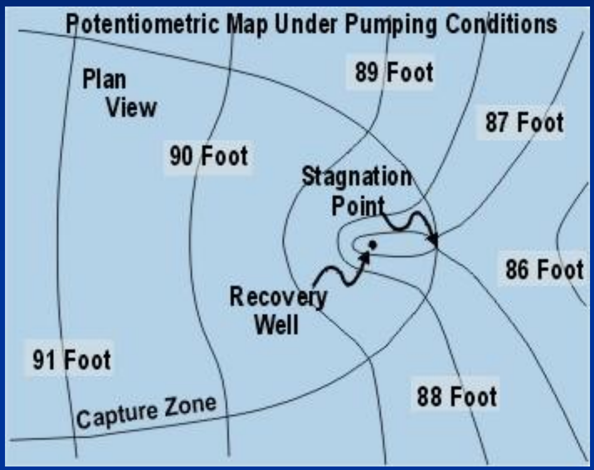


At any given point, drawdown = sum of the drawdown curves at that point

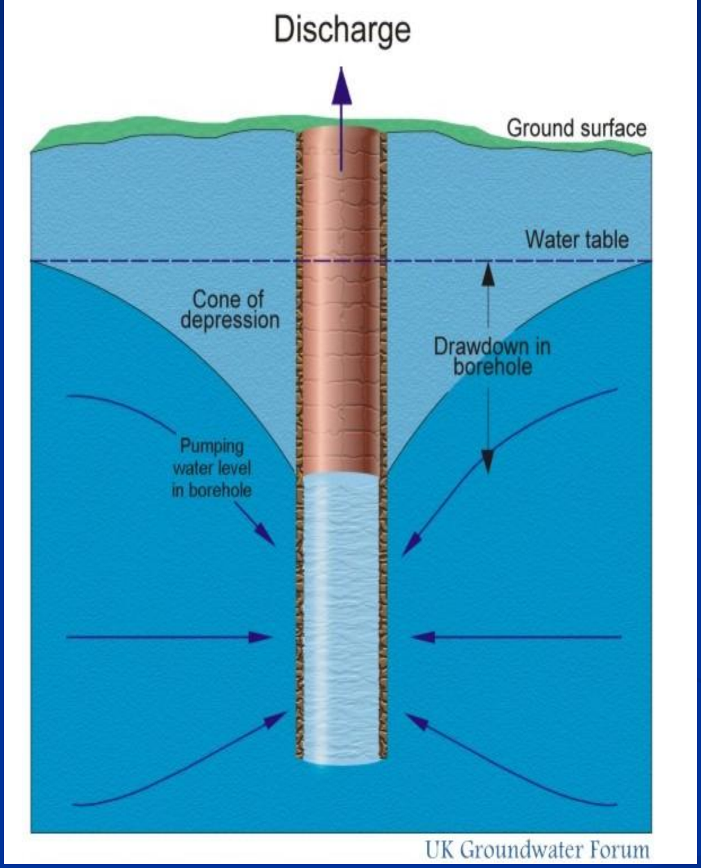
Well Hydraulics – Interference Effects

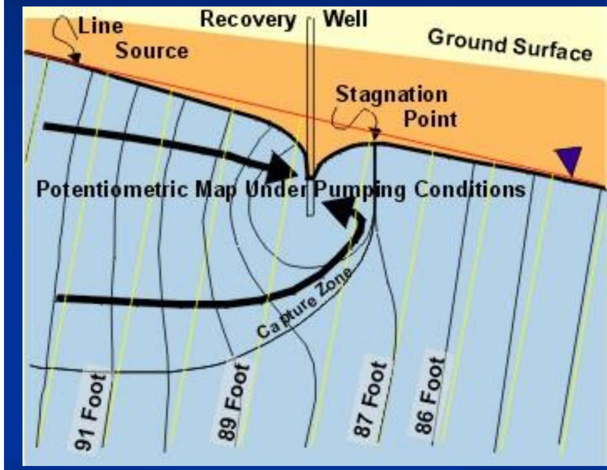


Well Hydraulics – Pumping Effects



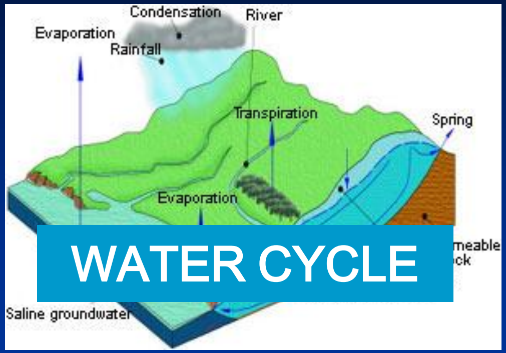
(Map View)

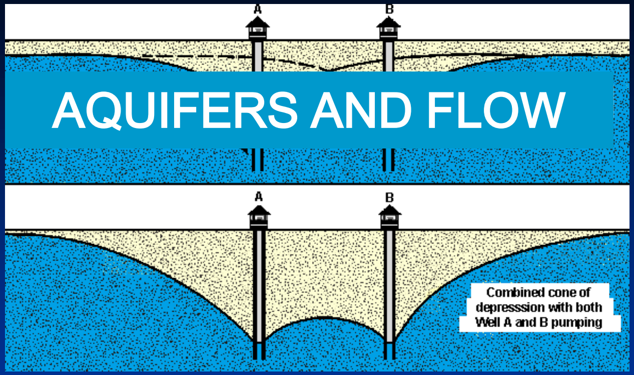




(Cross-Section View)

Capture zone is **NOT** synonymous with radius of influence


Condensation
River
Evaporation
Rainfall
Transpiration
Spring
Evaporation
Saline groundwater
WATER CYCLE


A
B
AQUIFERS AND FLOW
A
B
Combined cone of depresssion with both Well A and B pumping


DRILL

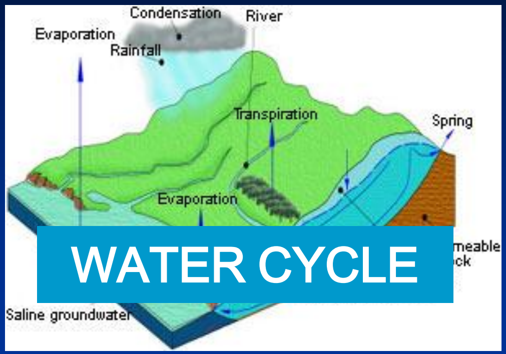

PROBLEMS
04 28 2005

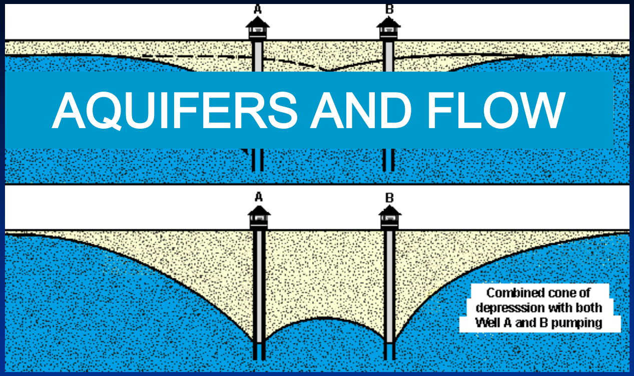
Pumps & Wells


CONSTRUCT


PUMP


TEST





Groundwater & Wells

Drilling and Drillers

All you need to know:

If it's turning to the right, the bit is moving down, nothing is falling, stuffs coming up, and nobody is running …

… it's *probably* an okay time to talk to the driller!

Well Drilling Methods

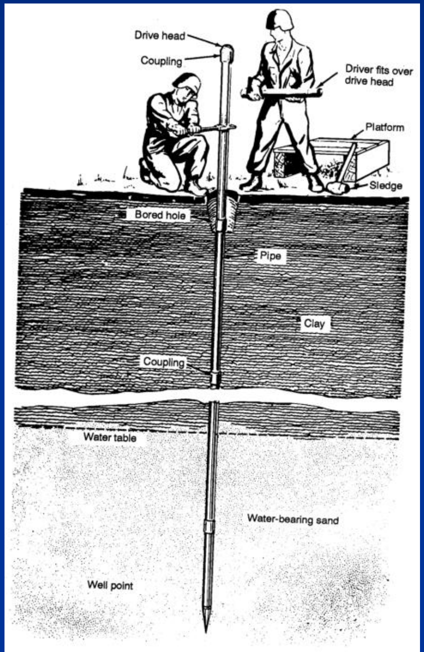


Figure 9-6. Drive-point well

- Hollow Stem Augers
- Cable Tool and Percussive
- Mud Rotary
- Air Rotary
- Other (Jetting, Direct Push, Sonic)

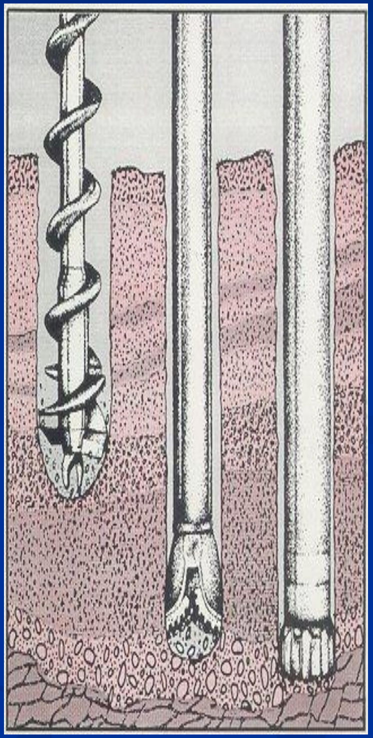


Table 5-1. Relative performance of different drilling methods in various types of geologic formations

Type of Formation	Cable Tool	Direct Rotary (with fluids)	Direct Rotary (with air)	Direct Rotary (Down-the-hole air hammer)	Direct Rotary (Drill through casing hammer)	Reverse Rotary (with fluids)	Reverse Rotary (Dual Wall)	Hydraulic Percussion	Jetting	Driven	Auger
Dune sand	2	5			6	5*	6	5	5	3	1
Loose sand and gravel	2	5			6	5*	6	5	5	3	1
Quicksand	2	5			6	5*	6	5	5		1
Loose boulders in alluvial fans or glacial drift	3-2	2-1			5	2-1	4	1	1		1
Clay and silt	3	5			5	5	5	3	3		3
Firm shale	5	5			5	5	5	3			2
Sticky shale	3	5			5	3	5	3			2
Brittle shale	5	5			5	5	5	3			
Sandstone—poorly cemented	3	4				4	5	4			
Sandstone—well cemented	3	3	5			3	5	3			
Chert nodules	5	3	3			3	3	5			
Limestone	5	5	5	6		5	5	5			
Limestone with chert nodules	5	3	5	6		3	3	5			
Limestone with small cracks or fractures	5	3	5	6		2	5	5			
Limestone, cavernous	5	3-1	2	5		1	5	1			
Dolomite	5	5	5	6		5	5	5			
Basalts, thin layers in sedimentary rocks	5	3	5	6		3	5	5			
Basalts—thick layers	3	3	4	5		3	4	3			
Basalts—highly fractured (lost circulation zones)	3	1	3	3		1	4	1			
Metamorphic rocks	3	3	4	5		3	4	3			
Granite	3	3	5	5		3	4	3			

*Assuming sufficient hydrostatic pressure is available to contain active sand (under high confining pressures)

Rate of Penetration:
1 Impossible
2 Difficult
3 Slow
4 Medium
5 Rapid
6 Very Rapid

Drilling - Cable Tool

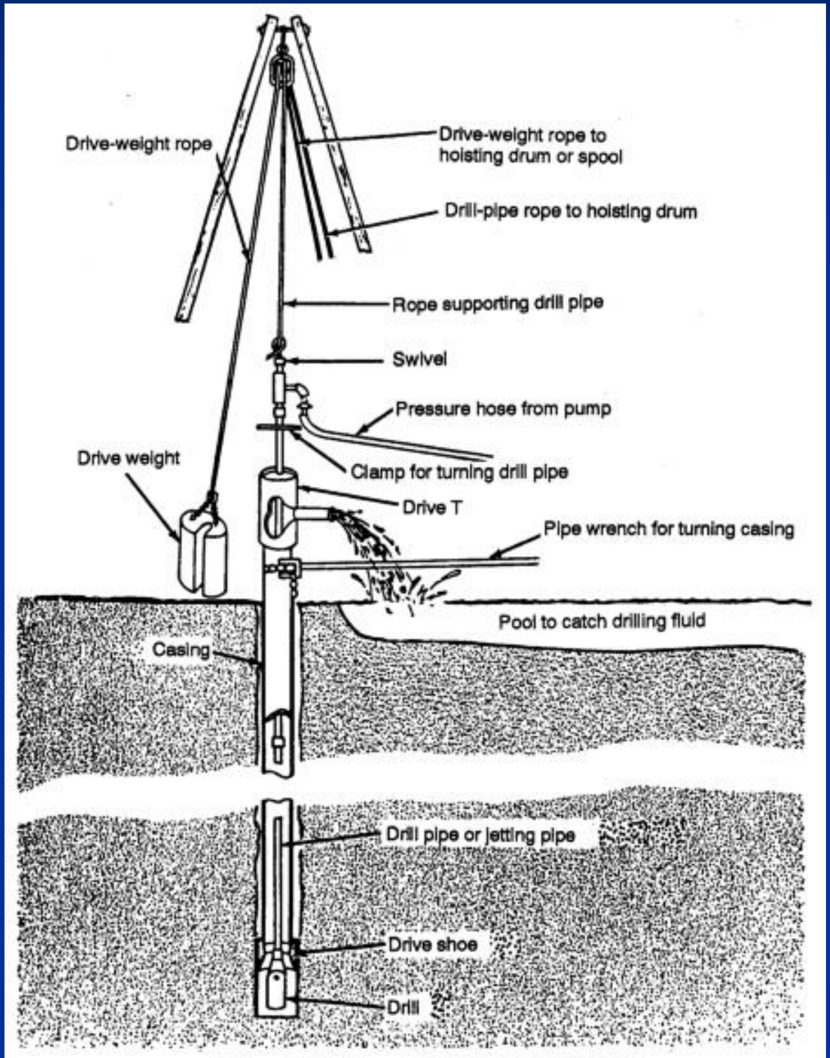


Figure 9-2. Percussion-type drilling rig

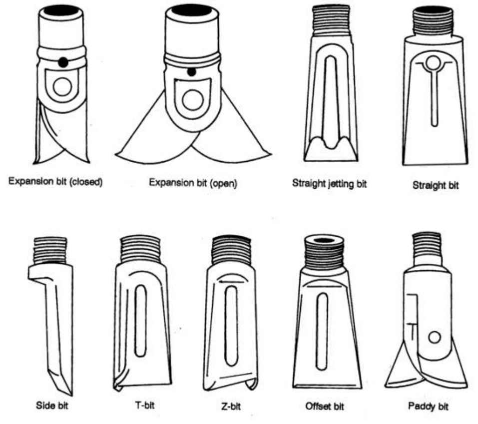
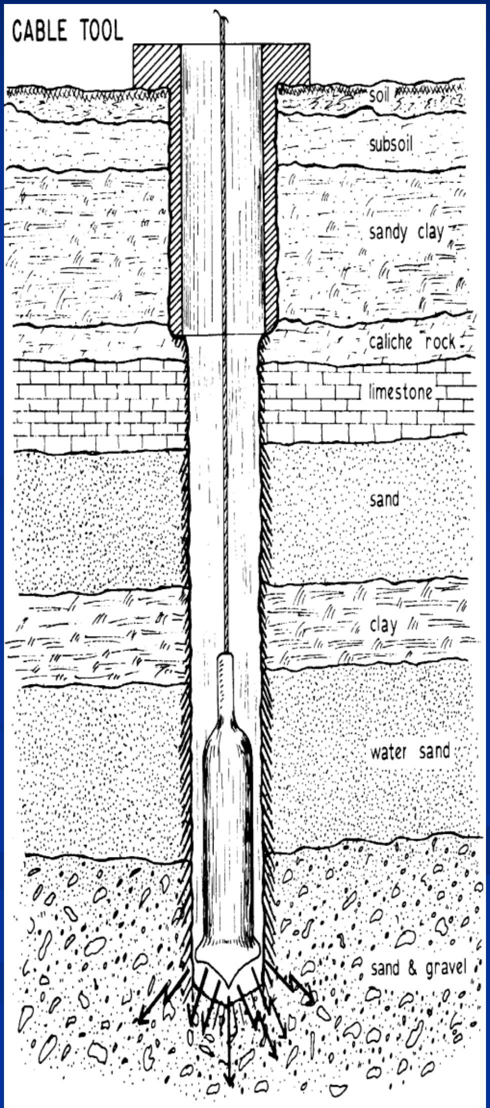
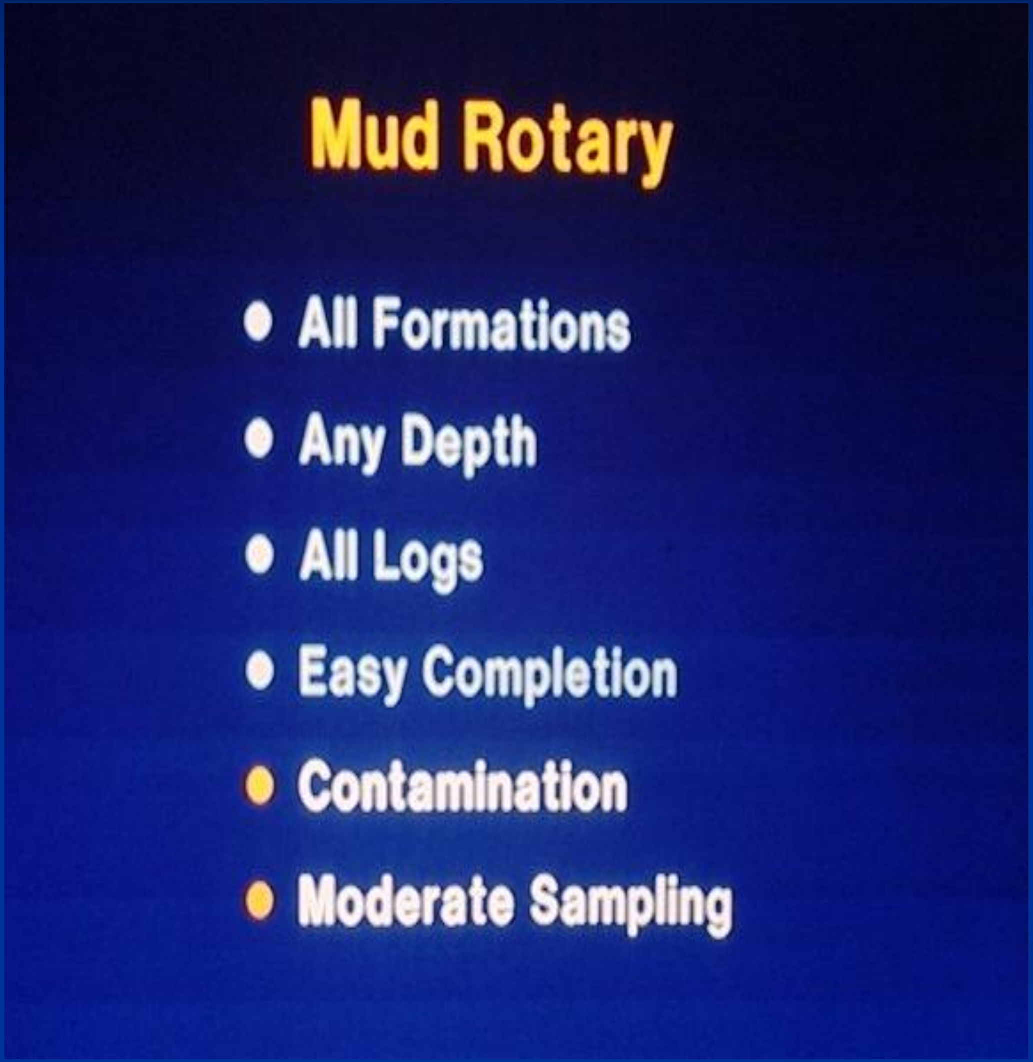


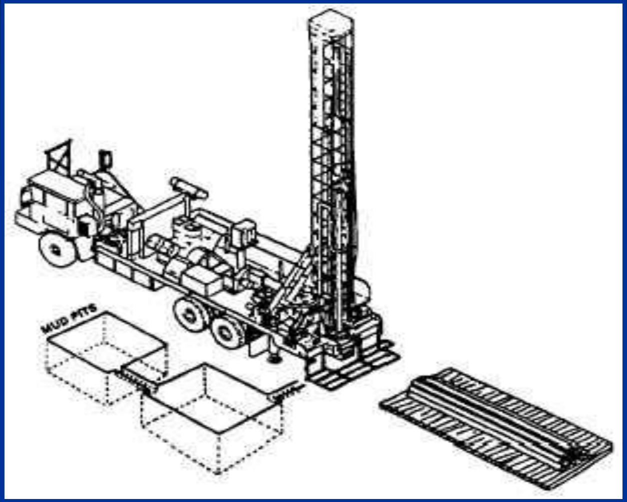
Figure 9-3. Bits



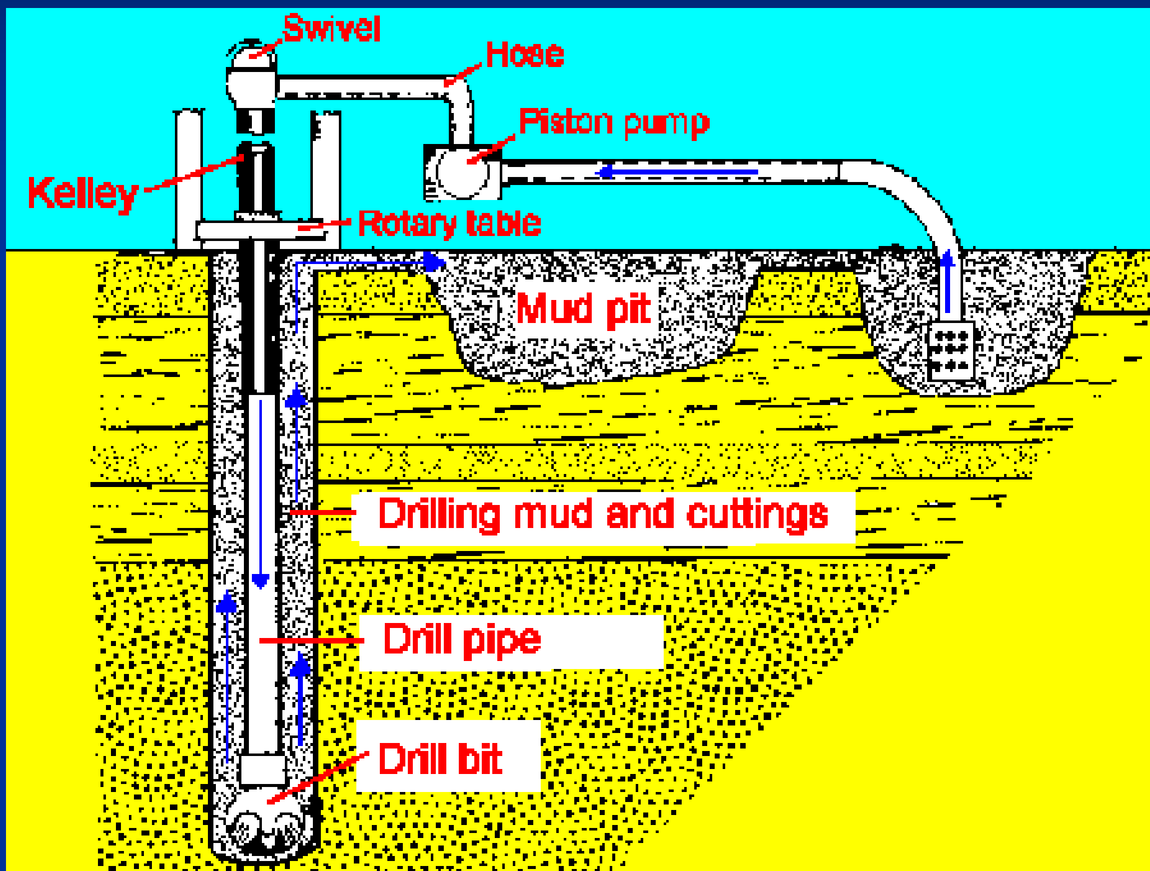
Drilling – Cable Tool / Percussive

Drilling – Mud Rotary





Drilling – Mud rotary:



Drilling – Mud Rotary: Reverse

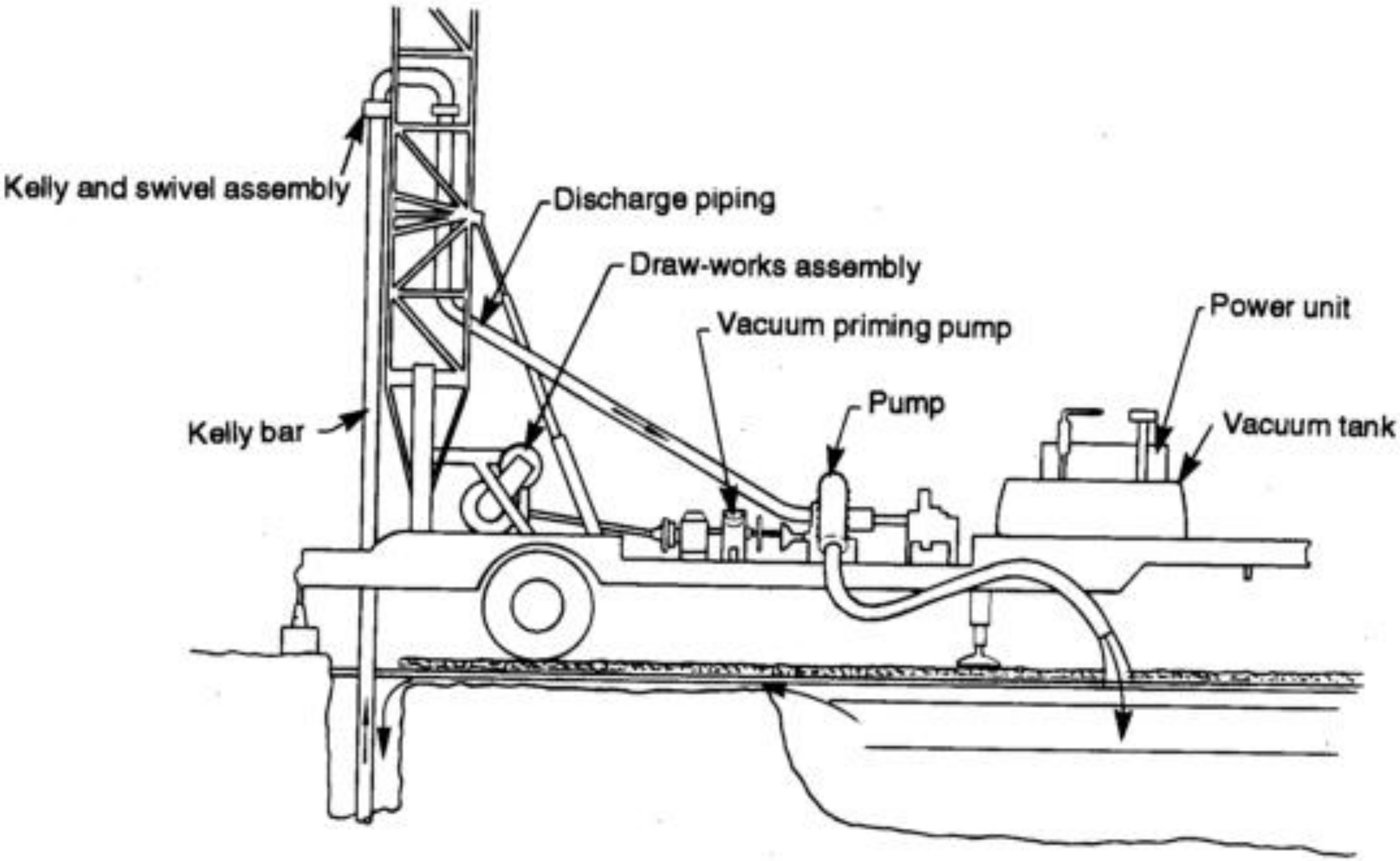


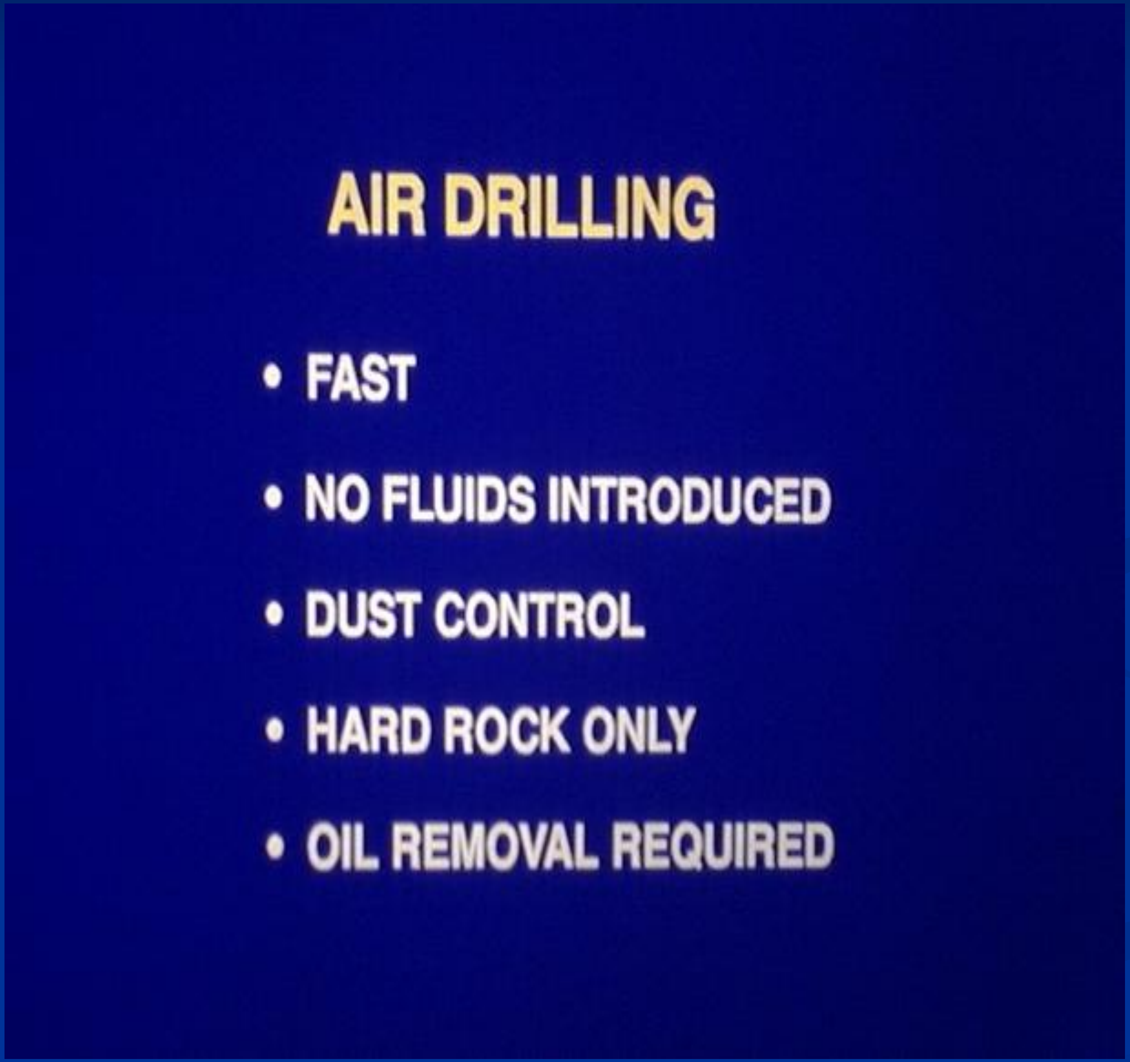
Figure 5-17. Reverse circulation rotary drilling

Drilling Fluids

- Water
- Bentonite
- Organic
- Other

Drilling – Fluids Control

Drilling – Air Rotary



Drilling – Air Rotary: Fluids Control

Drilling – Geophysical Logs

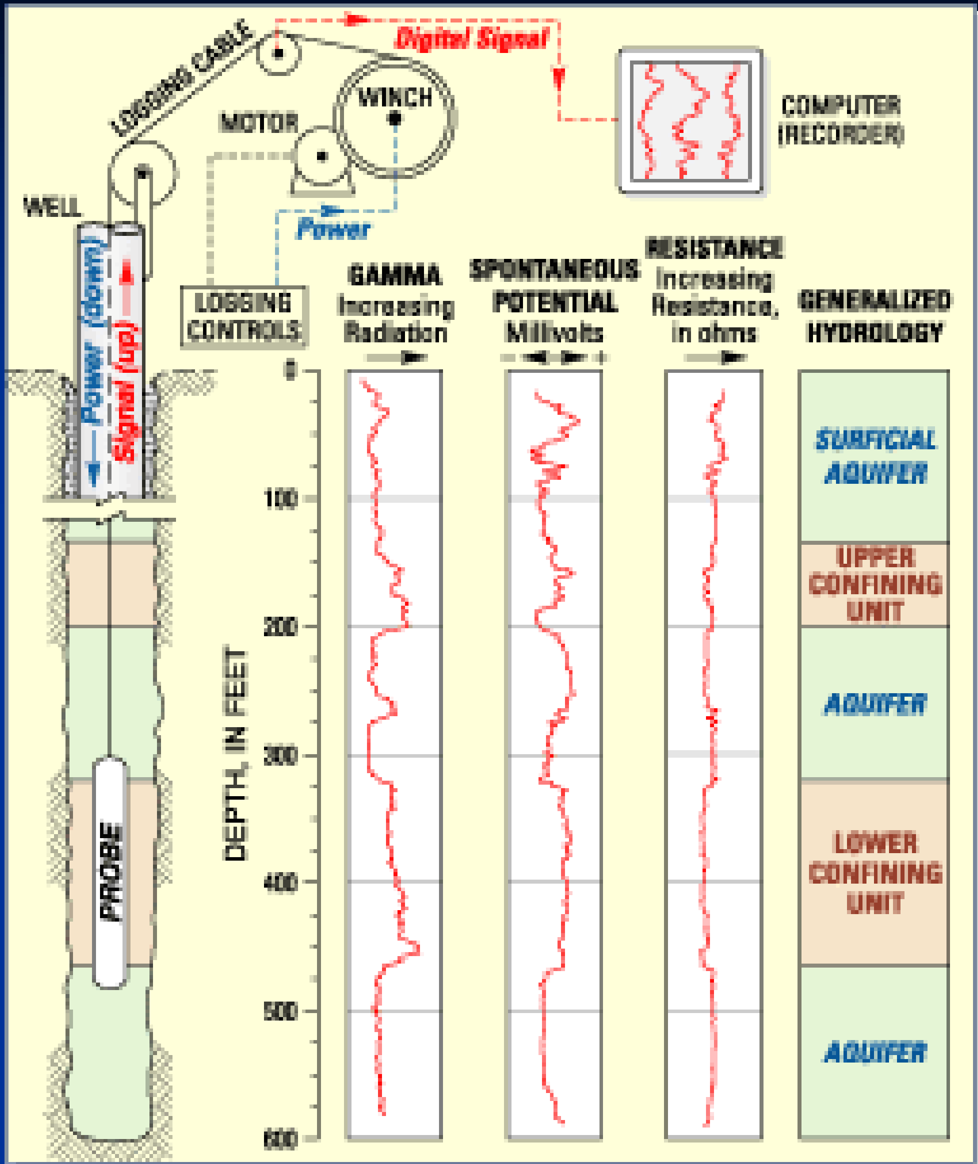
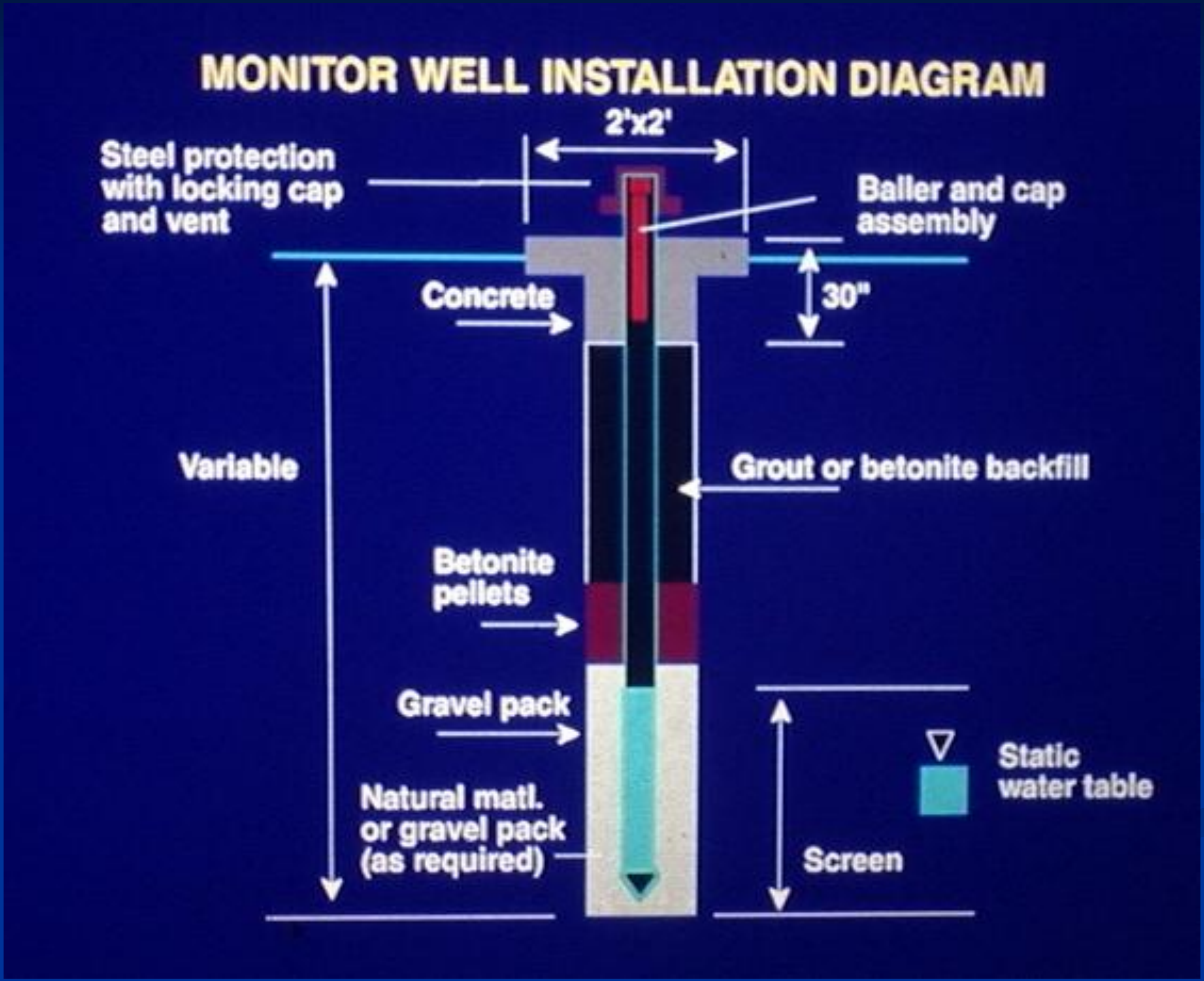


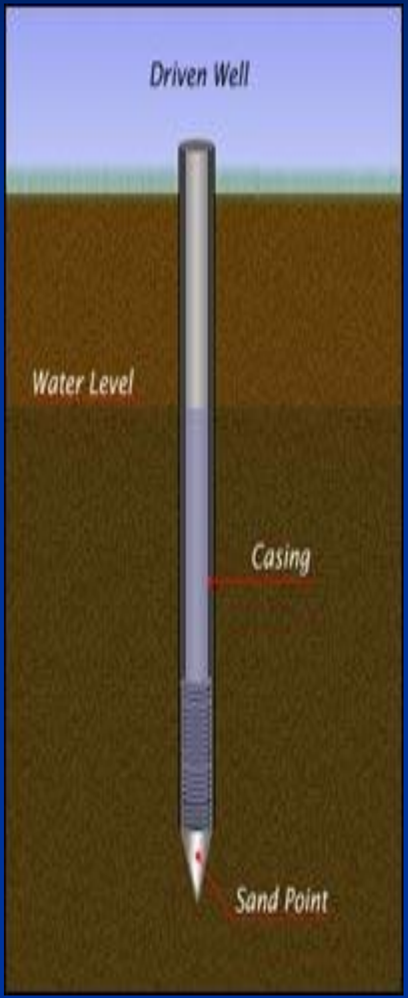
Diagram of geophysical well-logging equipment and recorded logs with generalized hydrologic units.

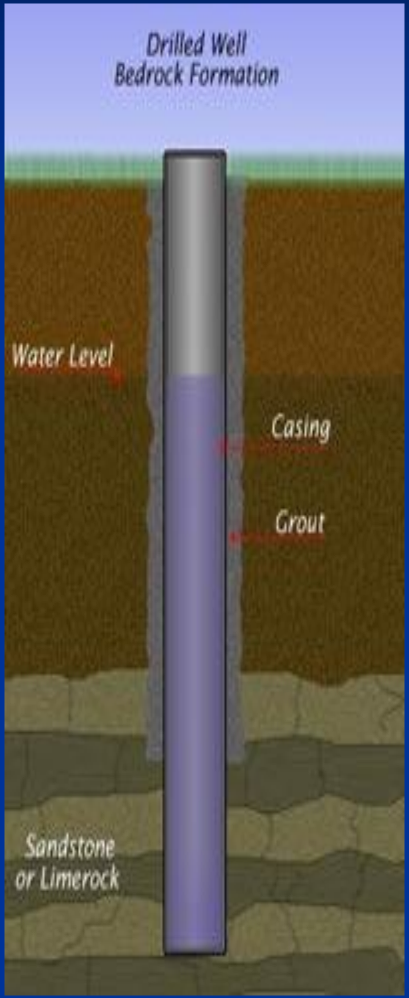
md.water.usgs.gov/.../html/Geophysics.gif

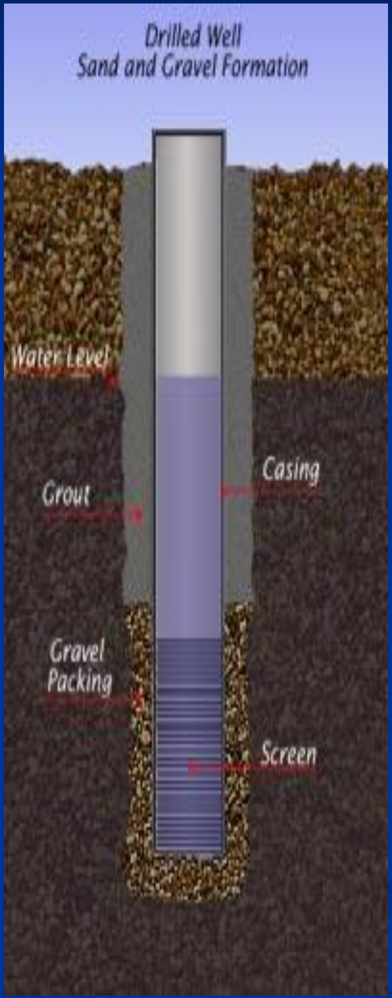
Well Construction – Basic Elements

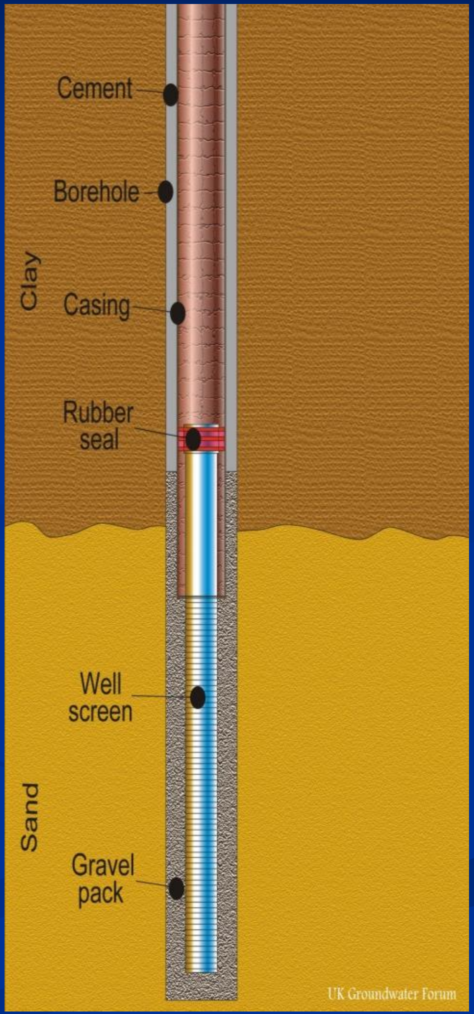


WELL CONSTRUCTION







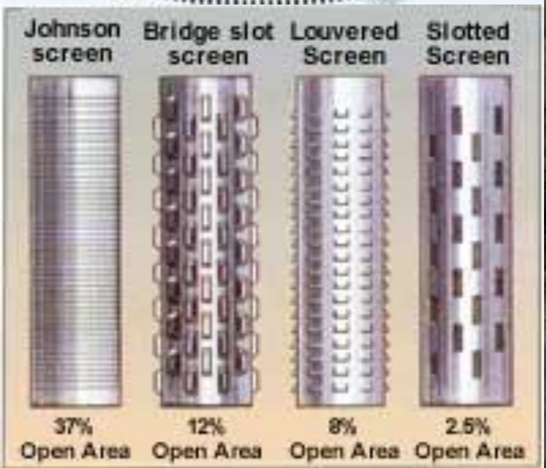


Vertical and straight alignment are CRITICAL to pump installation and wear

WELL CONSTRUCTION MATERIALS

- PVC
- STAINLESS STEEL
- TEFLON
- CARBON STEEL
- FIBERGLASS

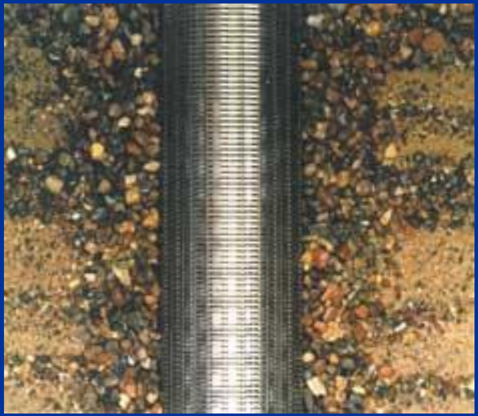
Well Construction - Screens



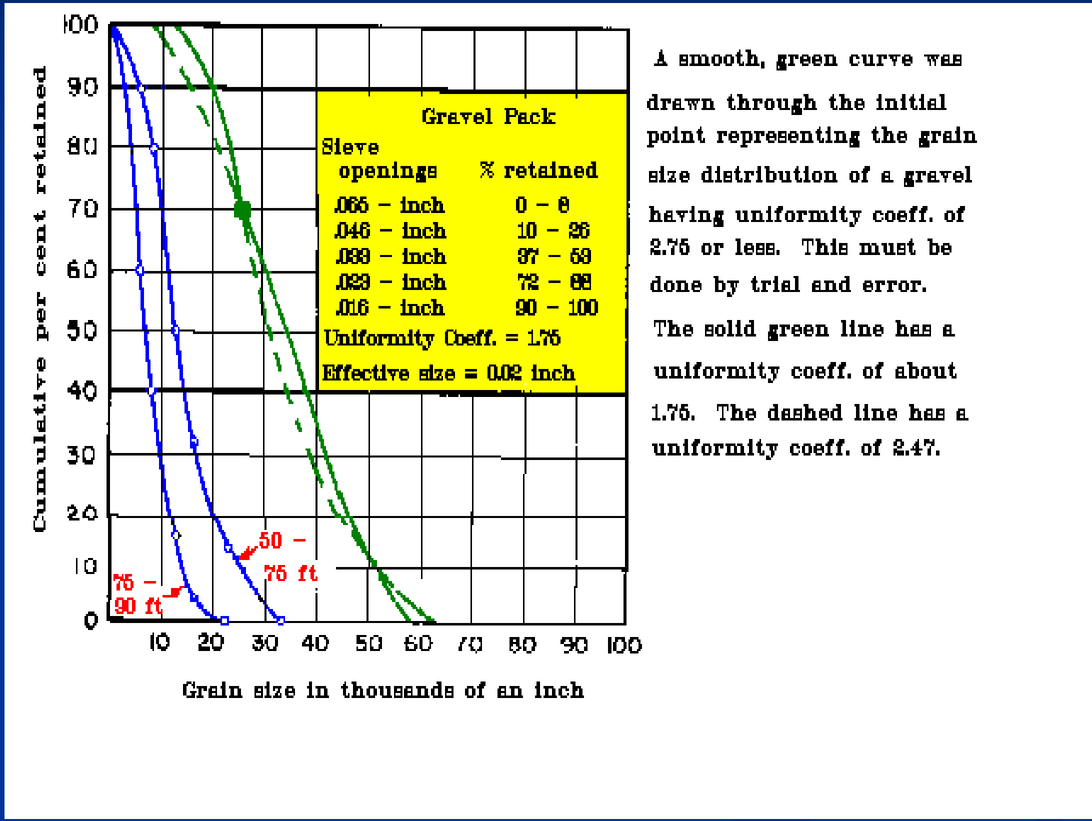
Well Construction - Casing

Well Construction - Centralizers

Well Construction – Gravel Pack

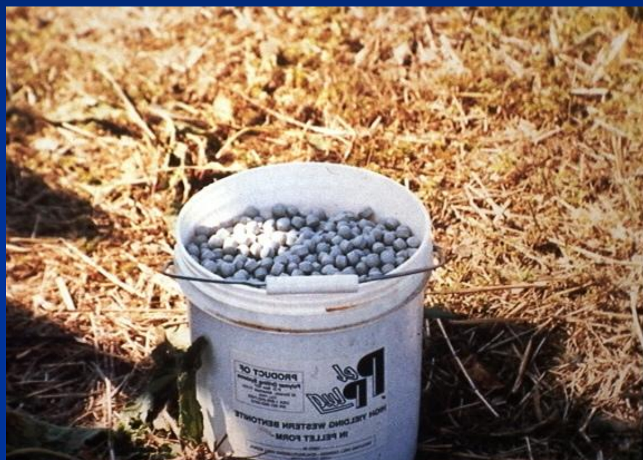


www.delawarewatersupply.com/images/future/wel...



abe.www.ecn.purdue.edu/.../images/gravel2.gif

Well Construction - Seal



Well Construction - Cementing

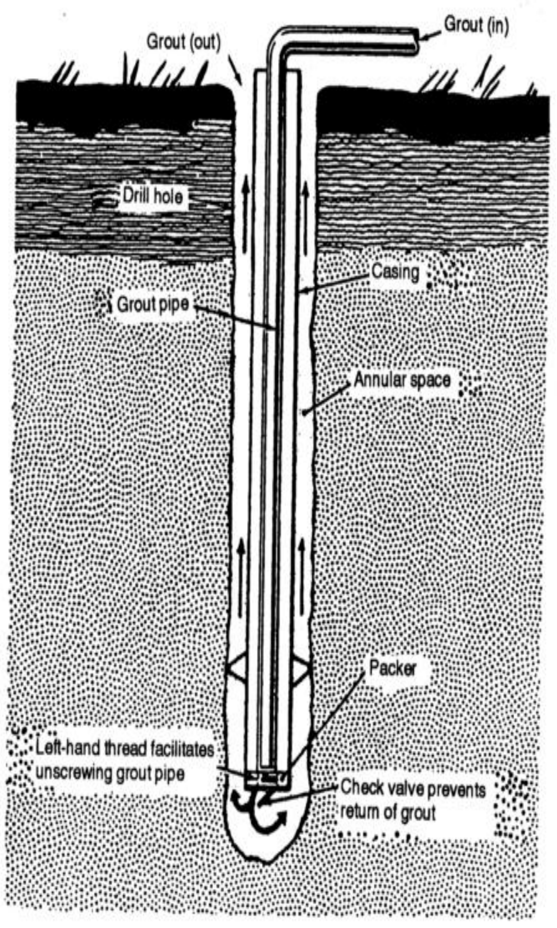


Figure 6-2. Inside-tremie grouting method

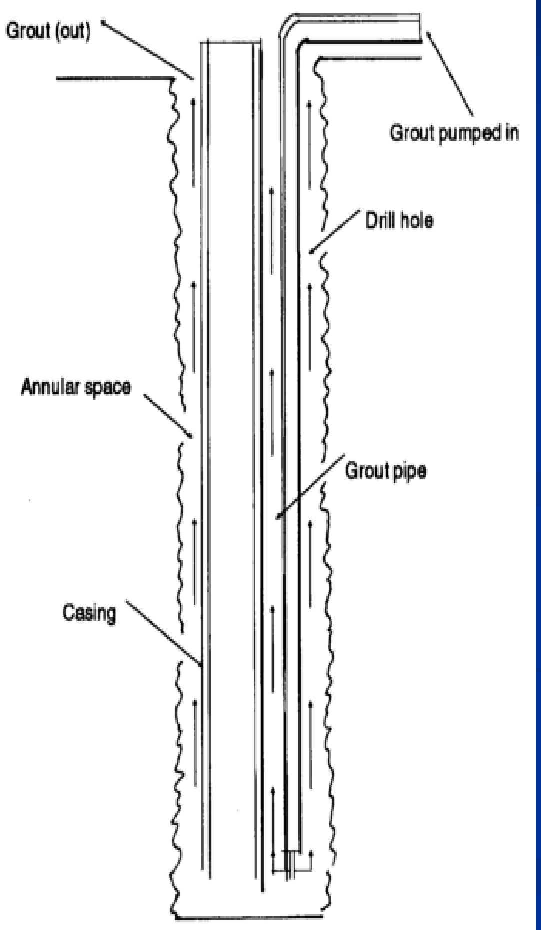
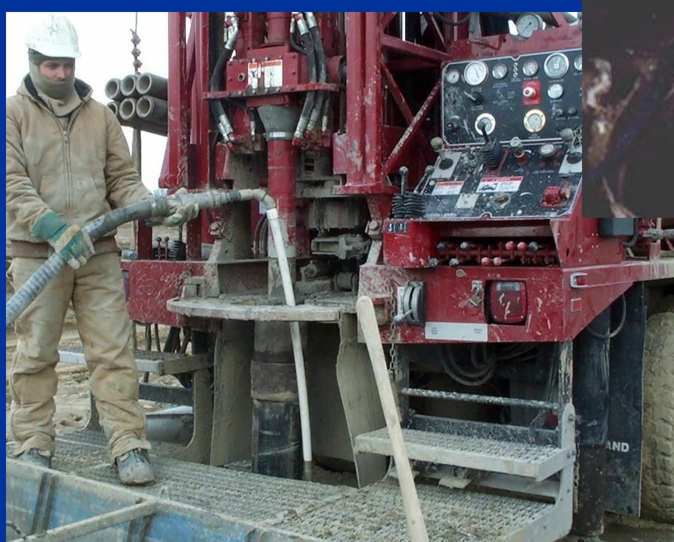


Figure 6-3. Outside-tremie grouting method

Well Construction – Cementing



Well Development

Well Development - Efficiency

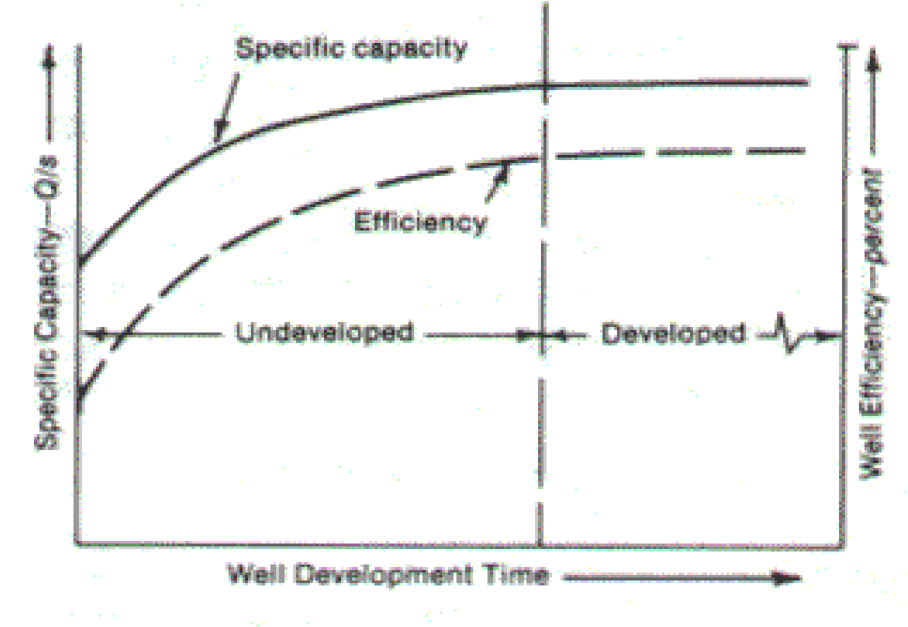
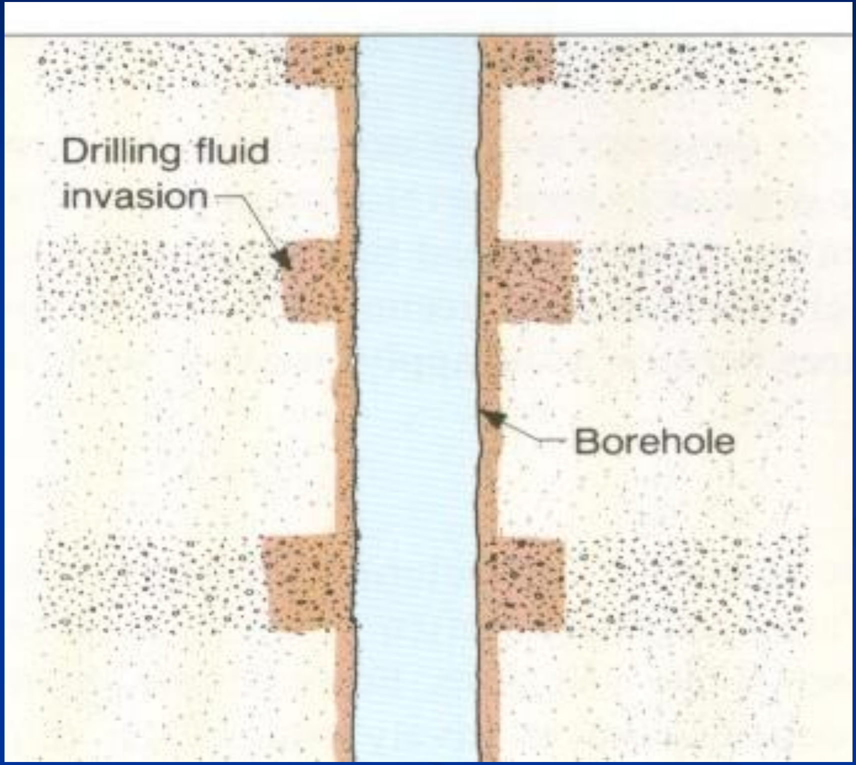
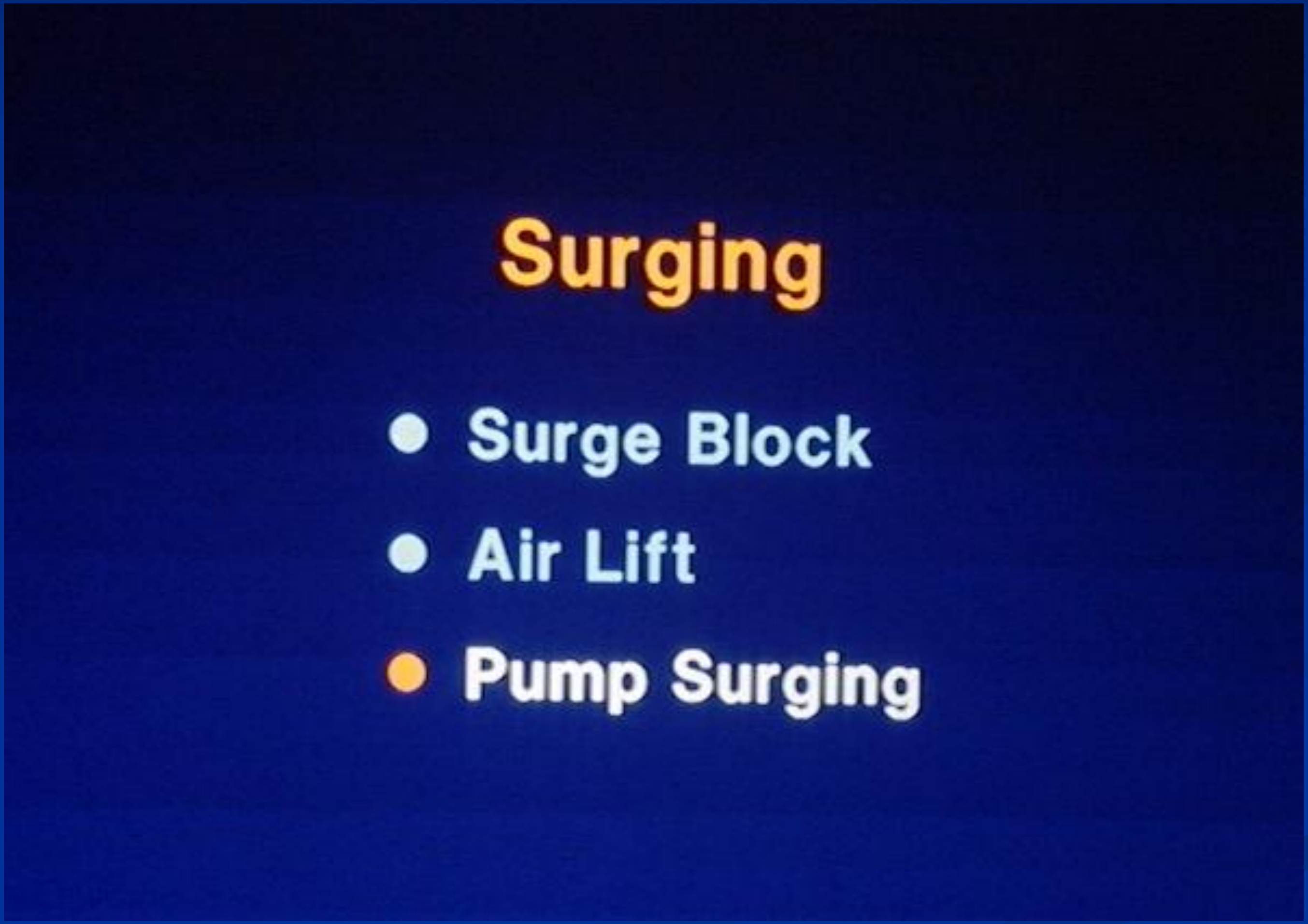


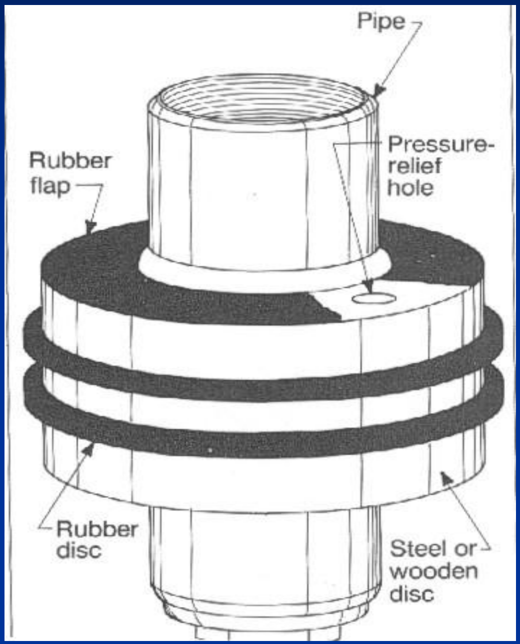
Figure 8. Specific capacity, efficiency, and well development

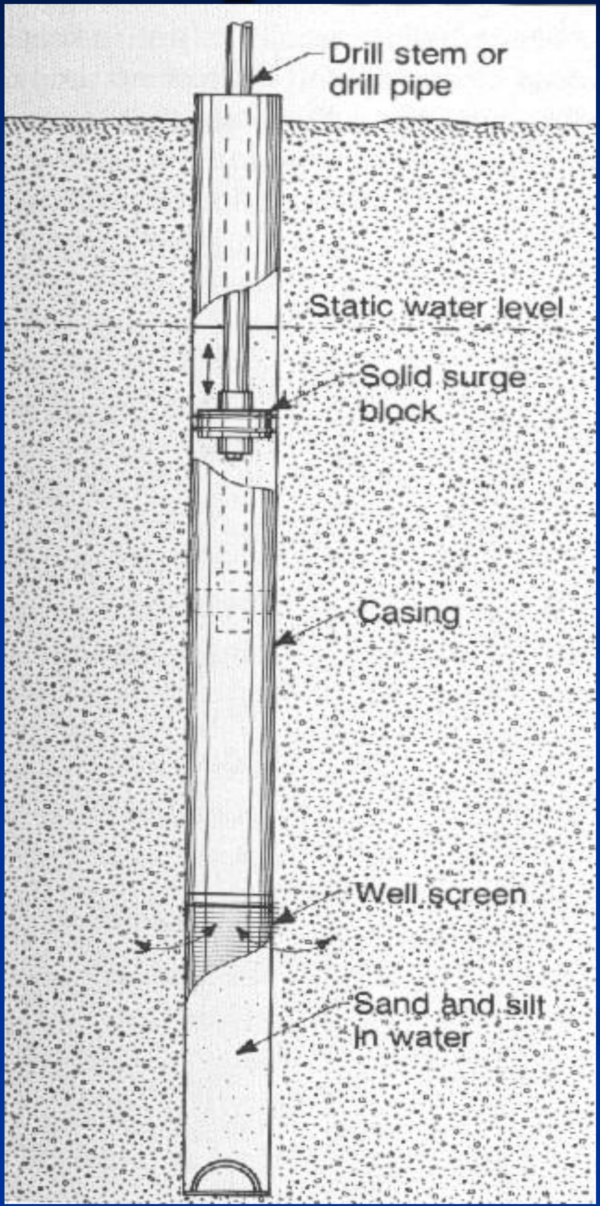


Well Construction - Development



Well Development - Surging





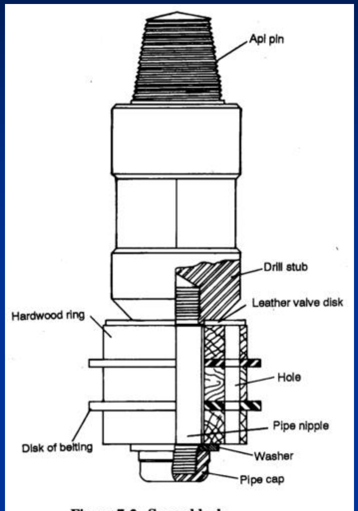
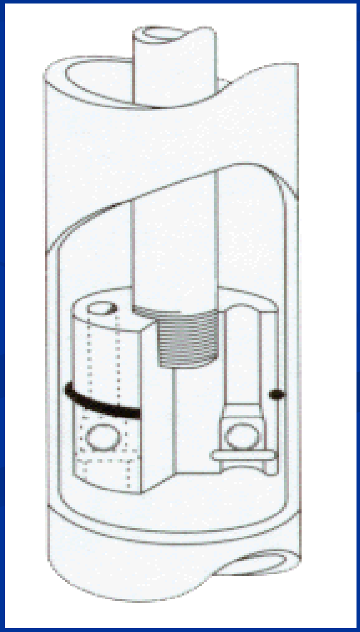


Figure 7-2. Surge block



Well Development - Jetting

Well Development – Air Lift

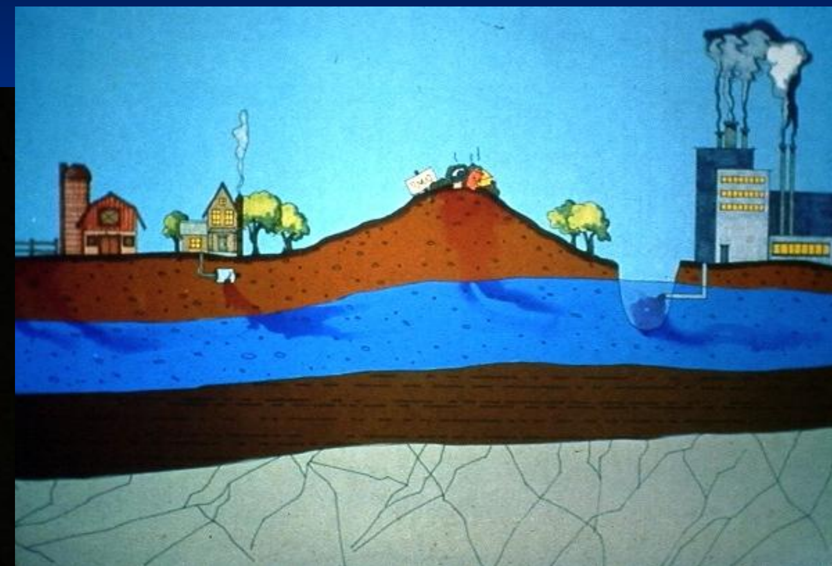
Well Construction – The End Product

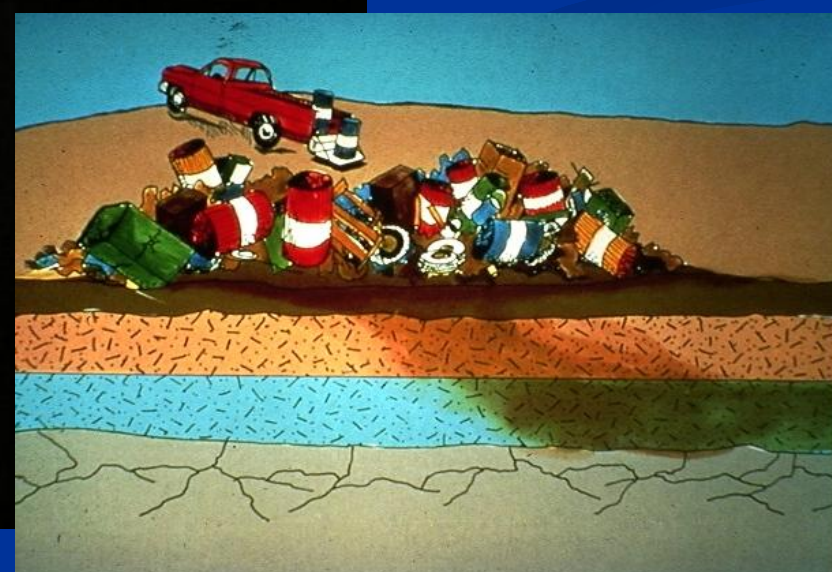
Wellhead Protection

Wellhead Protection and Threats

PRIORITIZED GROUND-WATER POLLUTION PROBLEMS

1. Landfills and Dumps
2. Waste Pits, Ponds, and Lagoons
3. Septic Tanks
4. Petroleum Exploration and Development
5. Agricultural Practices
6. Natural Leaching
7. Land Application of Wastes
8. Artificial Recharge
9. Water Well Construction
10. Ground Water Development
11. Waste Piles and Stock Piles
12. Mining
13. Storage Tanks and Transmission Lines
14. Accidental Spills
15. Drainage Wells and Sumps
16. Surface Water
17. Highway Salting
18. Industrial Disposal Wells
19. Air Pollution





Wellhead Protection

- OSE (1978 NMSA 72-12)
  - No Requirements
  - Water rights, permits, water use, metering
- OSE (NMAC 19.27.4) Drillers Regs
  - 50 feet setback between wells
  - 18-inch casing height above ground surface
  - Surface pad (4 sq ft, 4-inch thick)
  - Access for water level monitoring
  - Annular Seal

Wellhead Protection

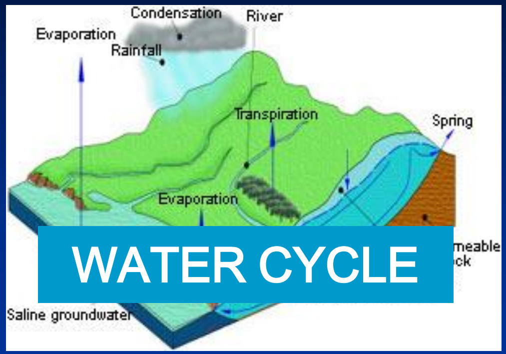
- NMED Drinking Water Bureau
  - Project approval, plan review
  - Sampling and inspection requirements
    - (40 CFR Part 141) or more stringent
  - Prevent contamination / disinfection requirement
  - Requirements for protection
    - Sanitary seal
    - Prevent contamination
    - Prevent unauthorized entry
  - SWAPP
    - Defaults to 200 ft radius for Zone A protection
    - Promotes management strategies and emergency planning

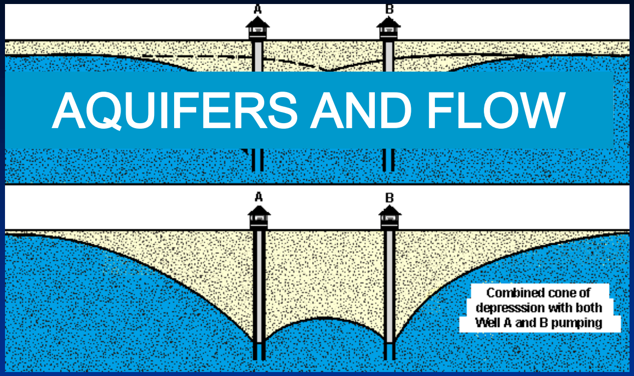
Wellhead Protection

- Bernalillo County Well Ordinance (Section 42)
  - Mirrors OSE Driller's Regs,
    - but pad is "3 feet in any direction from casing"
  - Not in Designated Flood Zones (A, AE, AH, AO)
  - <u>Setback Distances in Table 1</u>
    - 10feet - property lines
    - 25 feet – arroyos and ditches
    - 100 feet – wells of others
    - 100 feet – septic disposal fields, streams, canals
    - 100 feet – USTs, animal pens , concrete sewers
    - 500 feet – known groundwater contaminant plumes

Wellhead Protection – Good?

Wellhead Protection - ?????





Groundwater & Wells

Pumping Tests – Time, Depth, Rate

Water Levels – Tape and Chalk

Limitations

- •Pre-know range of water level
- •Falling water / condensate
- •Short tapes
- •Tapes >300 ft uncommon

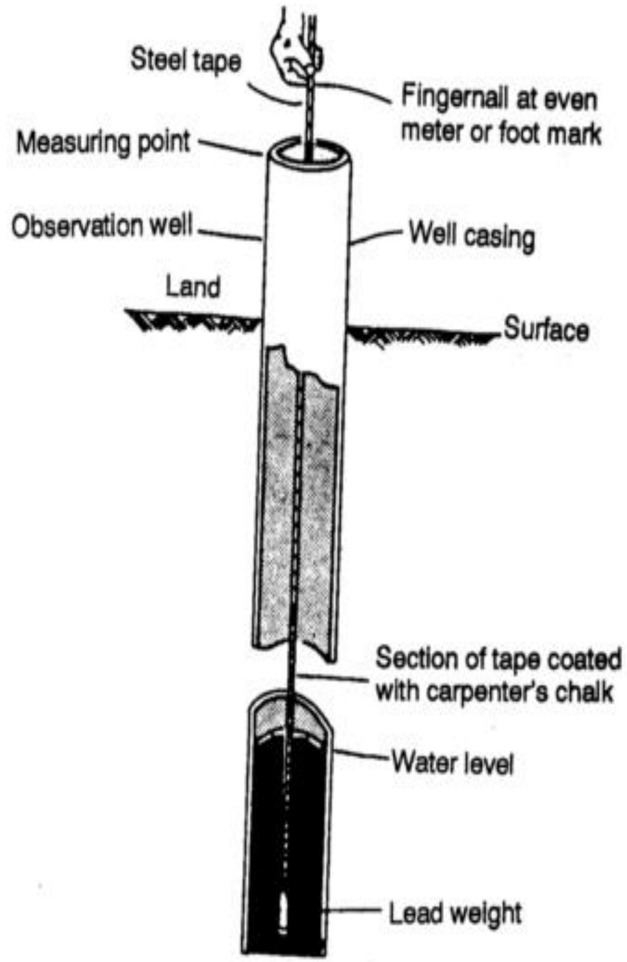


Figure 8-3. Steel-tape measurement method

Water Levels – E-Line / M-Scope

Limitations

- 1/100th, not feet and inches
- Some just have 5ft markings
- Dead batteries
- Audible or visible signal vs. background conditions
- Some creep with age
- Can wrap/hang on pump or pipe (just tie-off)

Water Levels - Transducers

Limitations

- Cost (minimum $700 each for vented)
- Ease of set-up and downloading
- Subject to Overpressure Damage
- Compensate for Barometric Changes
- Vented subject to condensate and kinking
- Unvented requires tracking barometric
- Things happen – vandalism, lightning

Water Levels – Air Line

Depth of Pipe – Max Pressure (ft) = Depth to Water

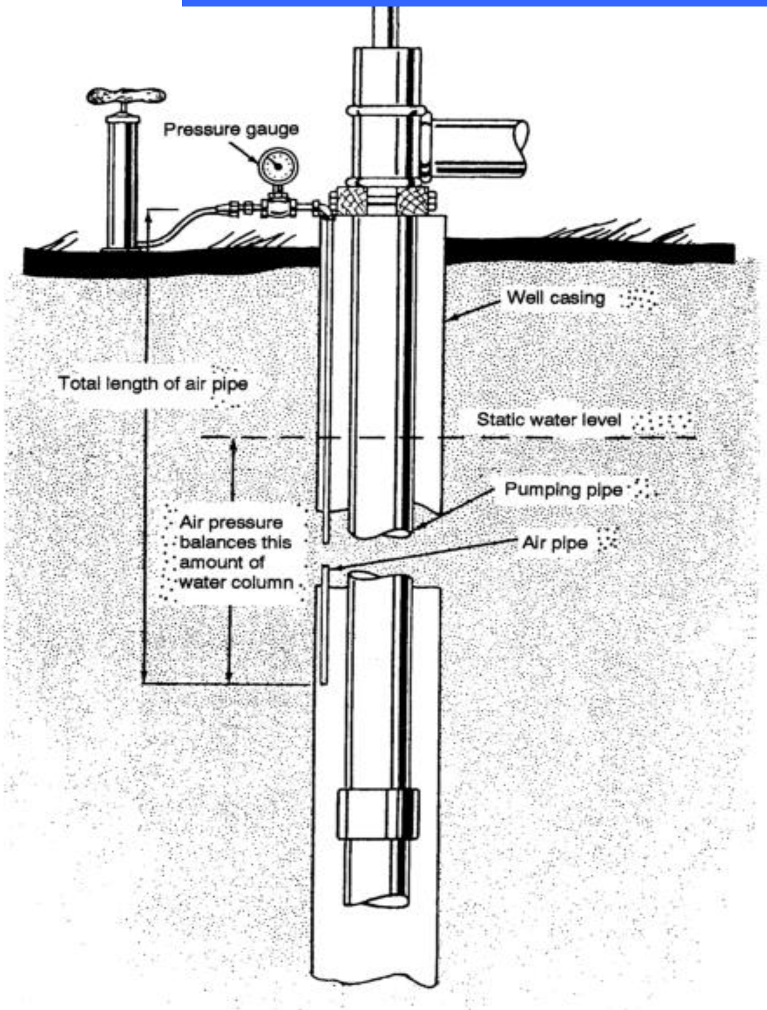


Figure 8-4. Air-line measurement method

Example:

300 ft – 25 psi (2.31 ft/psi) = Depth

300 ft – 57.75 (ft) = 292.25 ft

Limitations

- Have to know depth of pipe
- Gauge must be accurate/working
- No leaks, holes, punctures in air line
- Needs to be well above pump intake and below water level

Pumping Tests – Flow Measurement

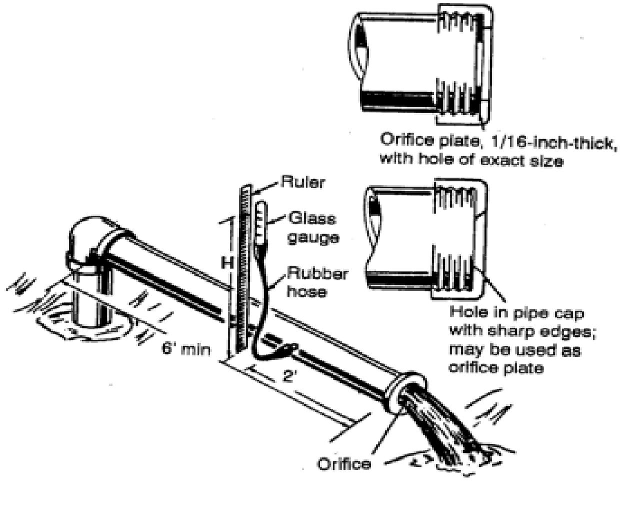


Figure 8-5. Circular-orifice flow meter

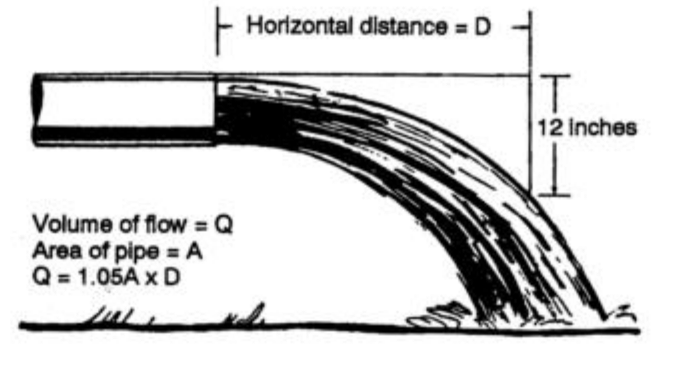
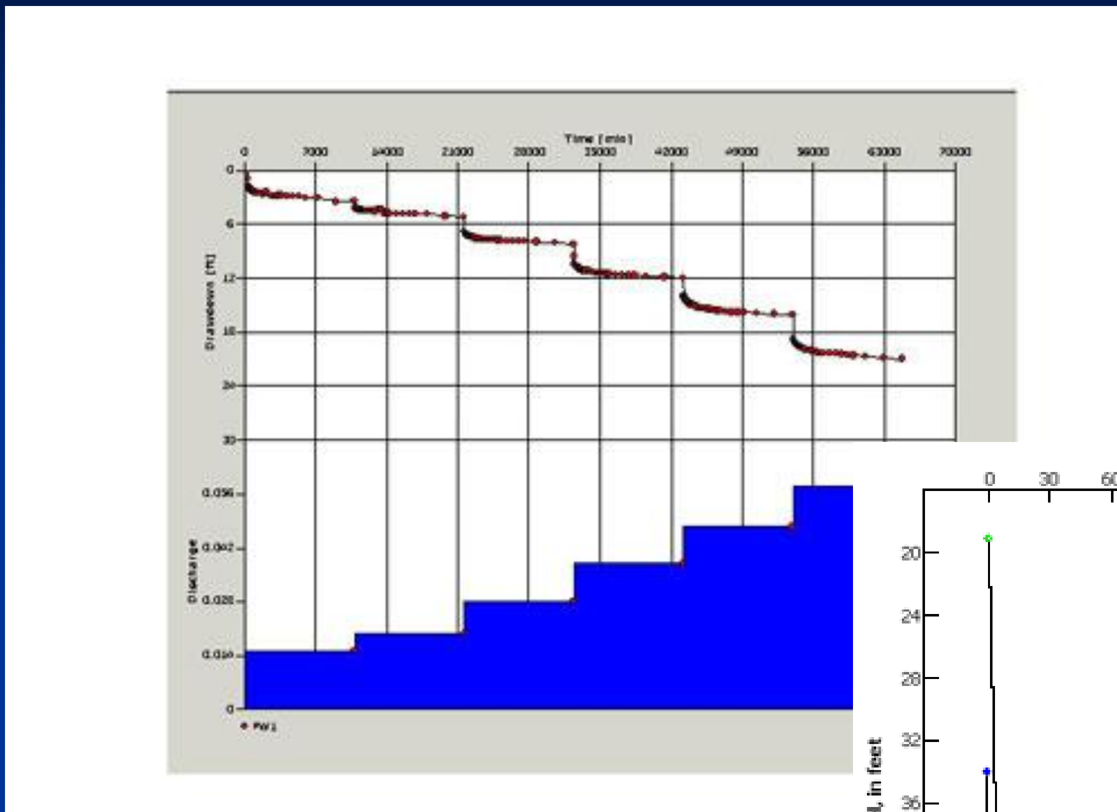
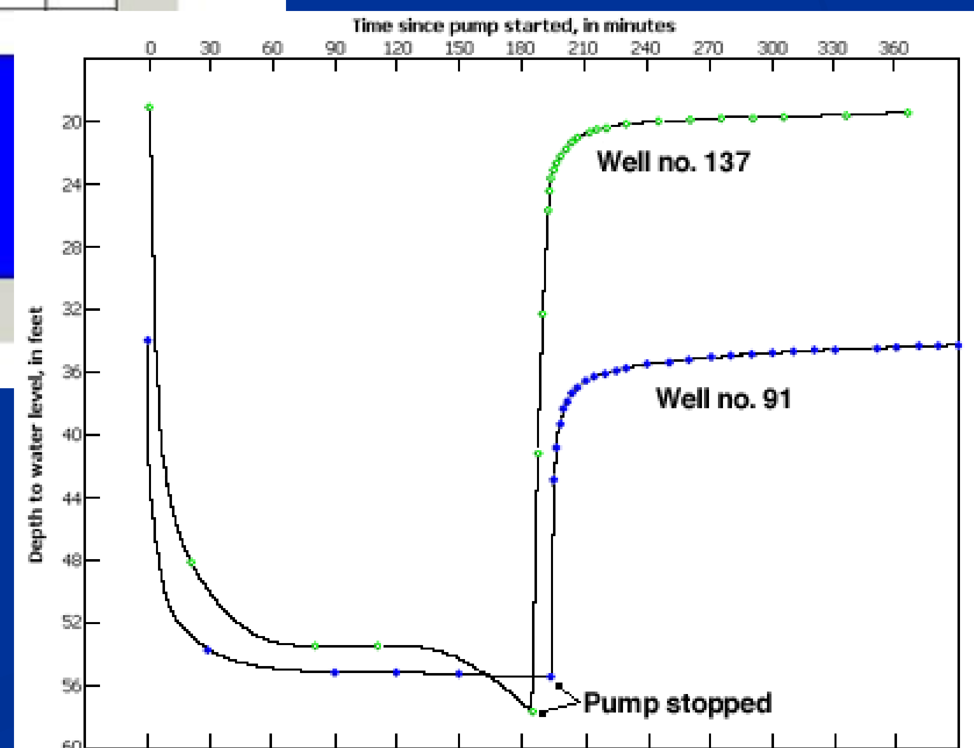


Figure 8-6. Open-pipe-flow measurement method

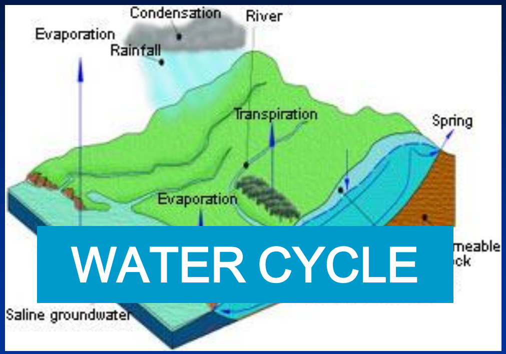
Pumping Tests – Flow Measurement

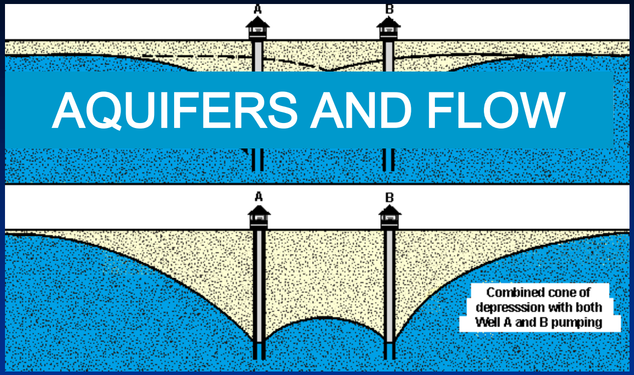
PUMPING TESTS AND WATER LEVELS



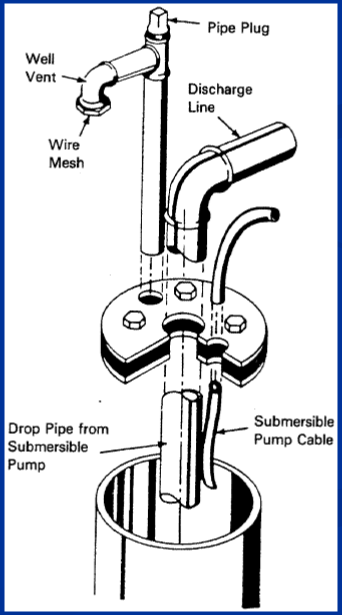


Groundwater & Wells





PUMPS


Pipe Plug
Well Vent
Discharge Line
Wire Mesh
Drop Pipe from Submersible Pump
Submersible Pump Cable

Pump Basics

Single Phase Submersible's & Centrifugal Pumps

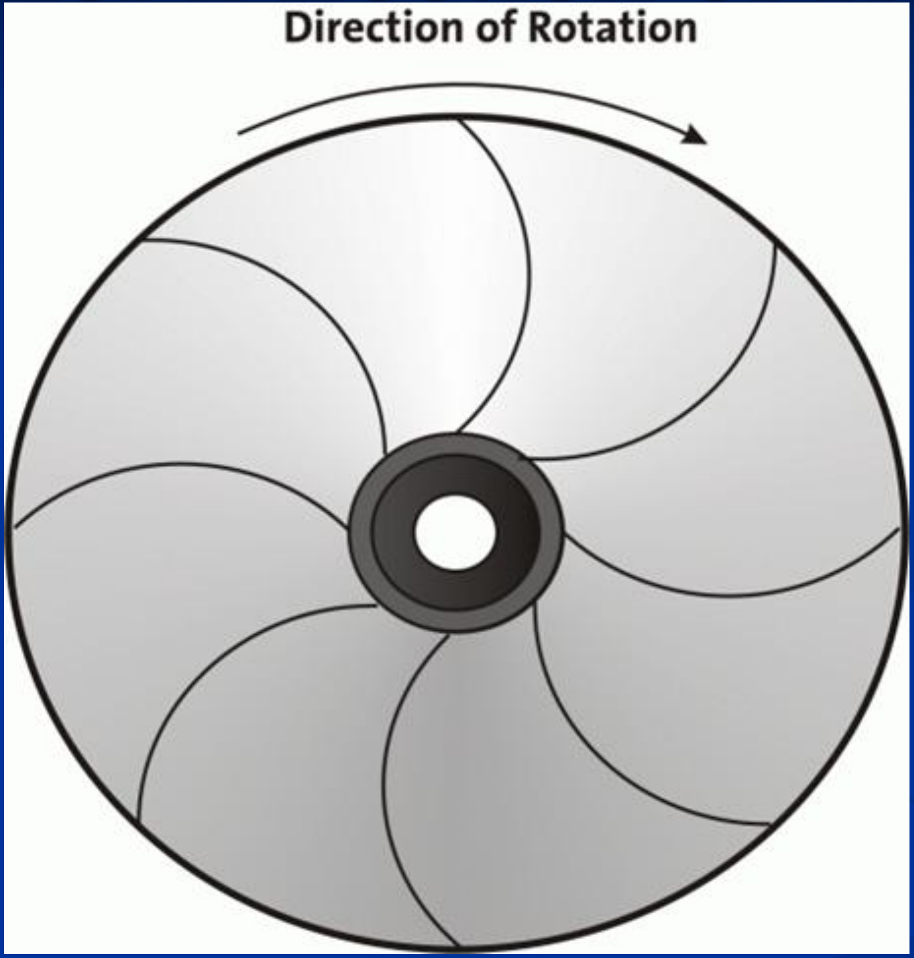
Originally Presented at NMRWA by:
James Bassett & TP Pump

TP PUMP™

Special Thanks
Text, Pictures & Data provided by:

Grundfos USA
Franklin Electric
Campbell Manufacturing
Amtrol Pressure Tanks
Simmons Manufacturing

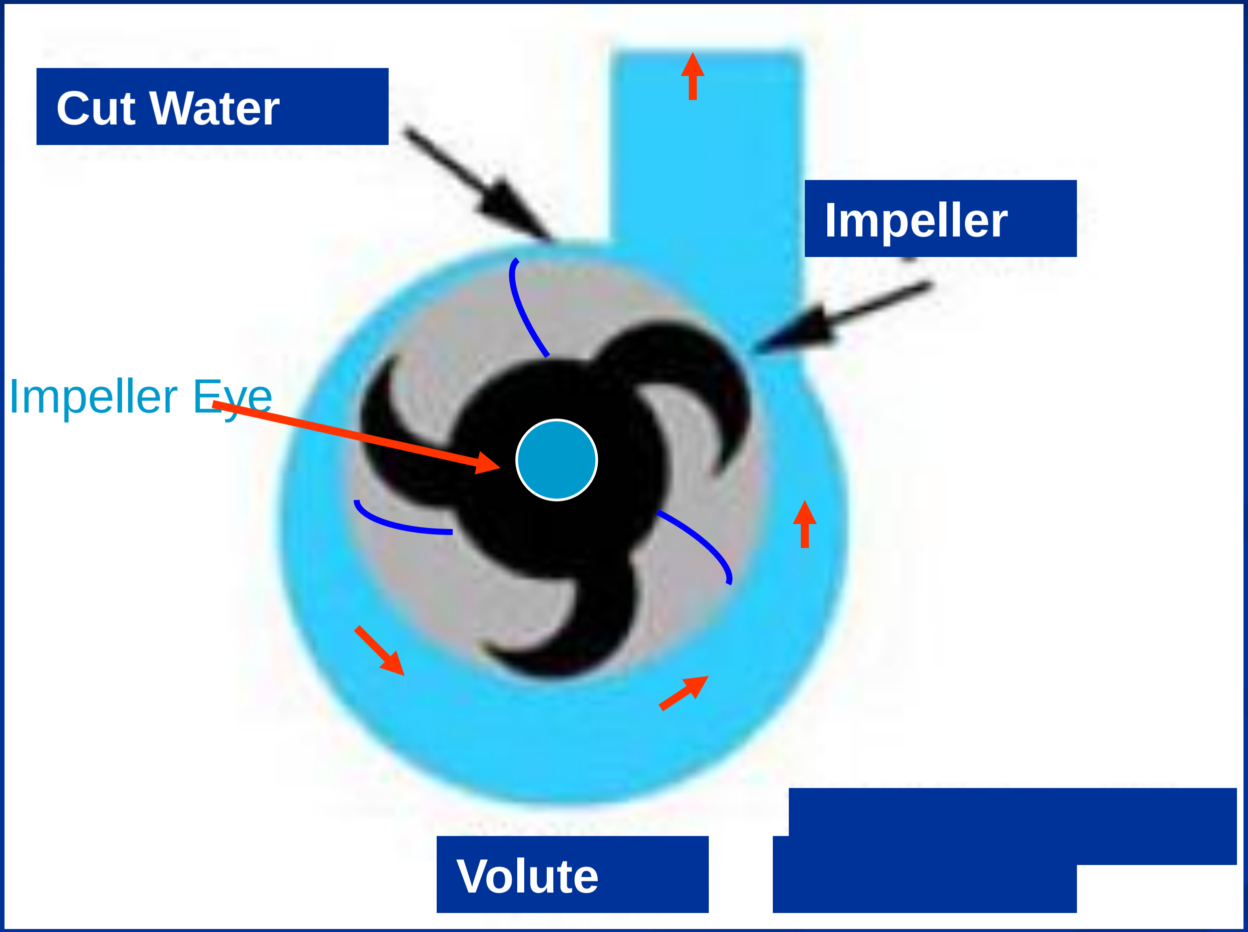
Impeller Direction of Rotation



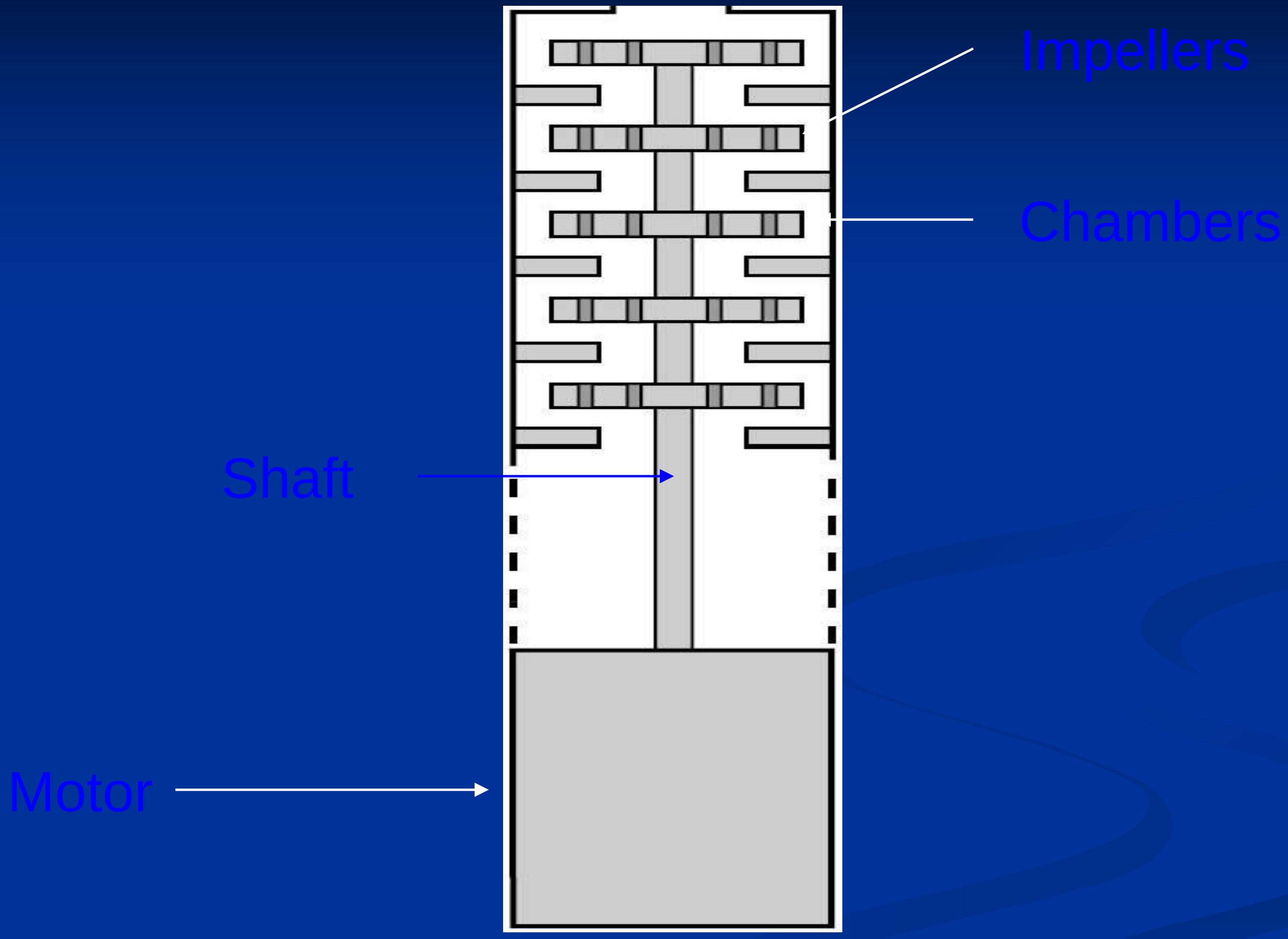
Centrifugal Force

TP PUMP™

Key Components Centrifugals



Main Parts of a Submersible Pump



Misc. System Components

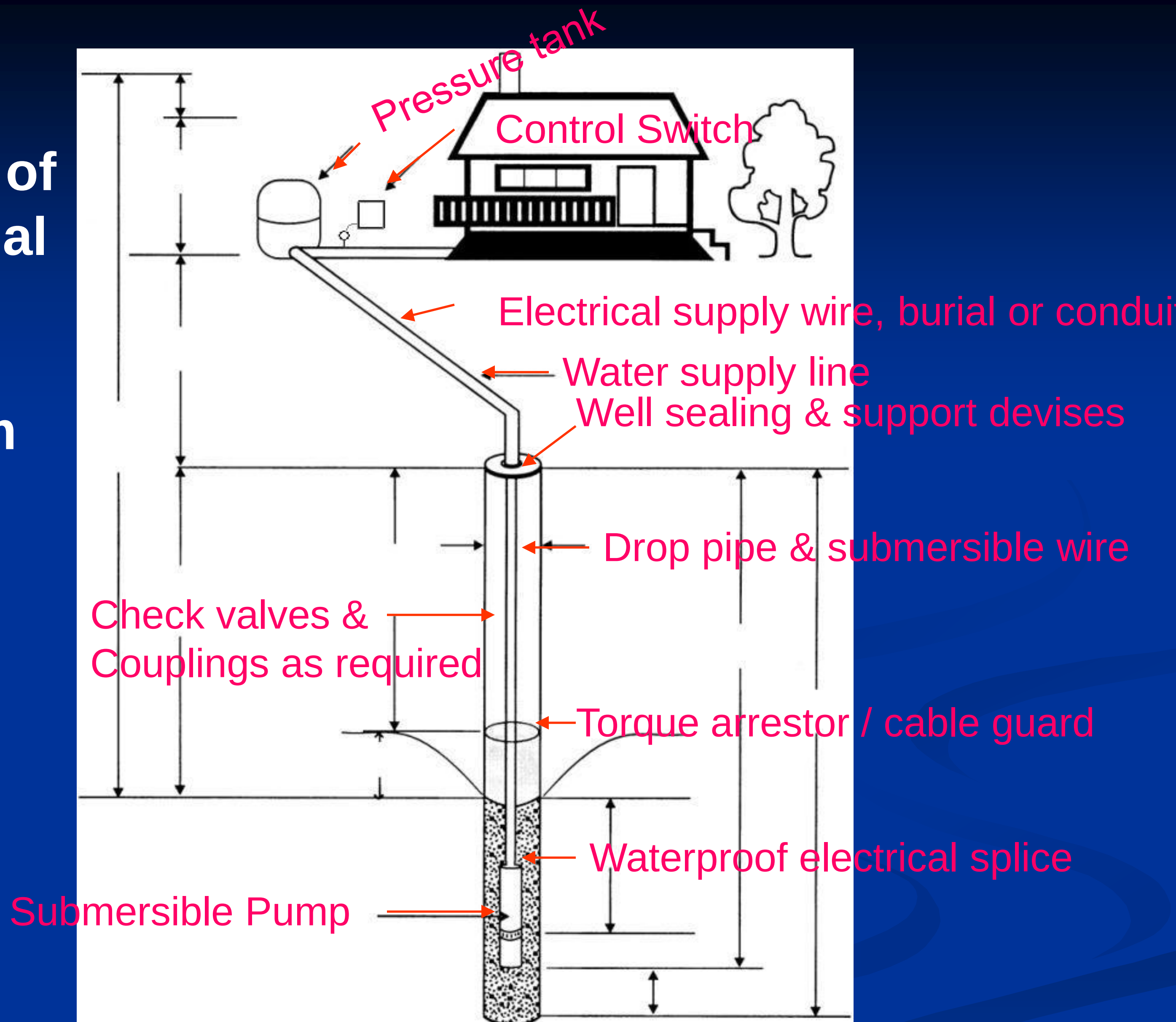
- Plumbing:

  Check Valves, shut-off valves, pressure relief valves, pressure gauges.

- Electrical:
  - Lighting or surge arrestors, control switches, pump / motor protective devises

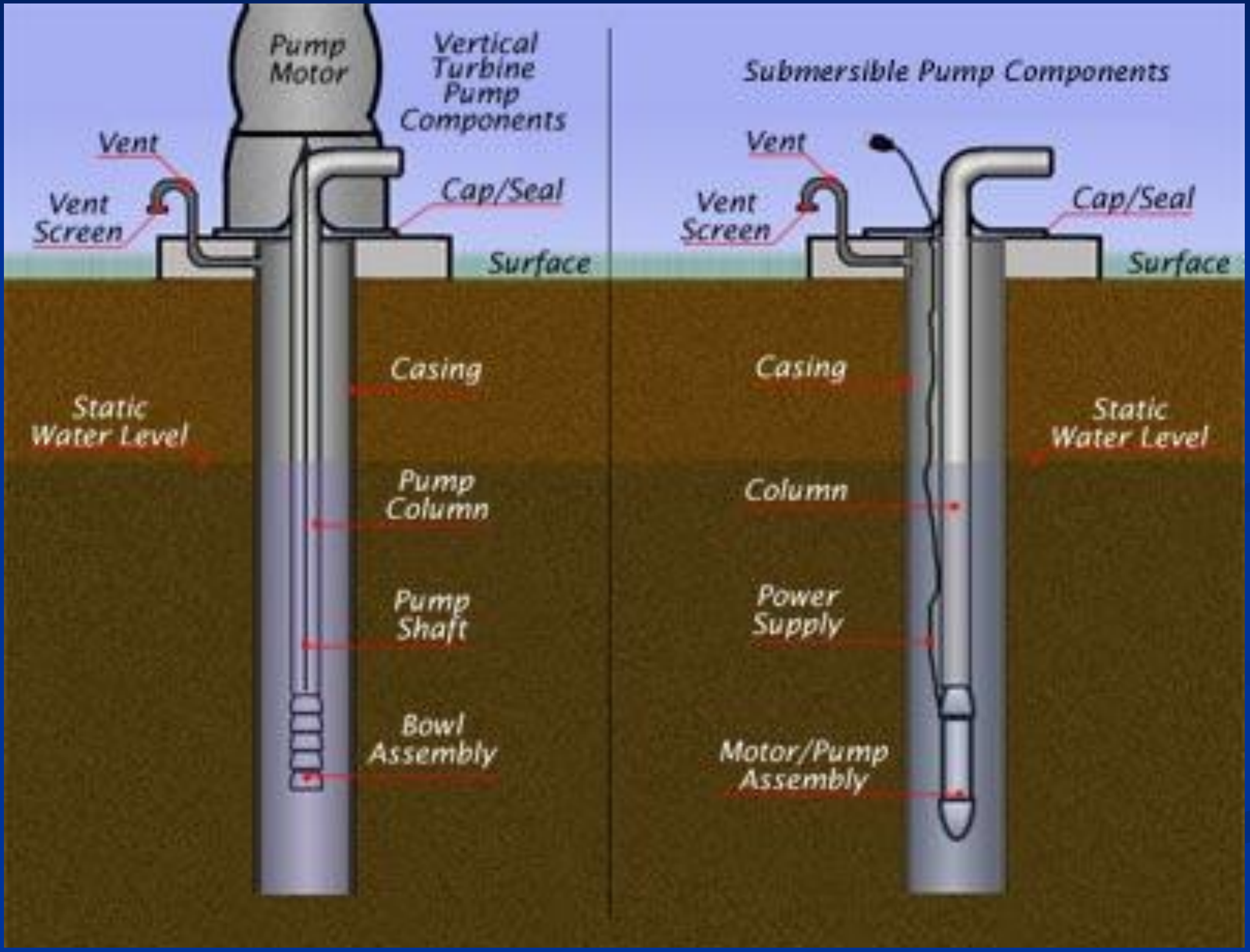
TP PUMP™

Components of a Conventional Fixed Speed Submersible Pump System



TP PUMP™

Pumps - Turbines and Submersibles



Pumps - Line-Shaft Turbines

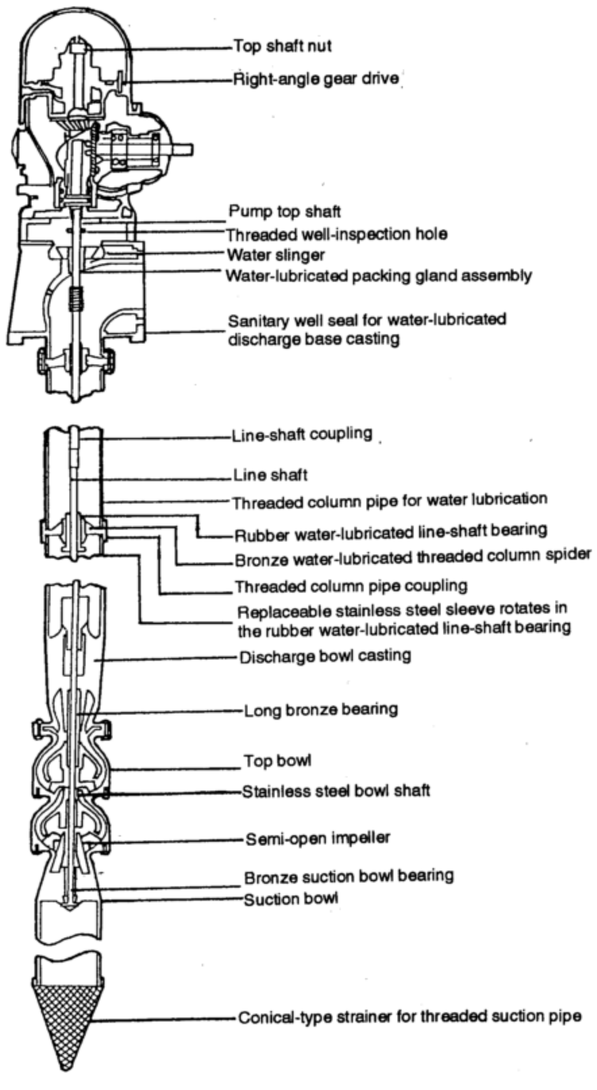
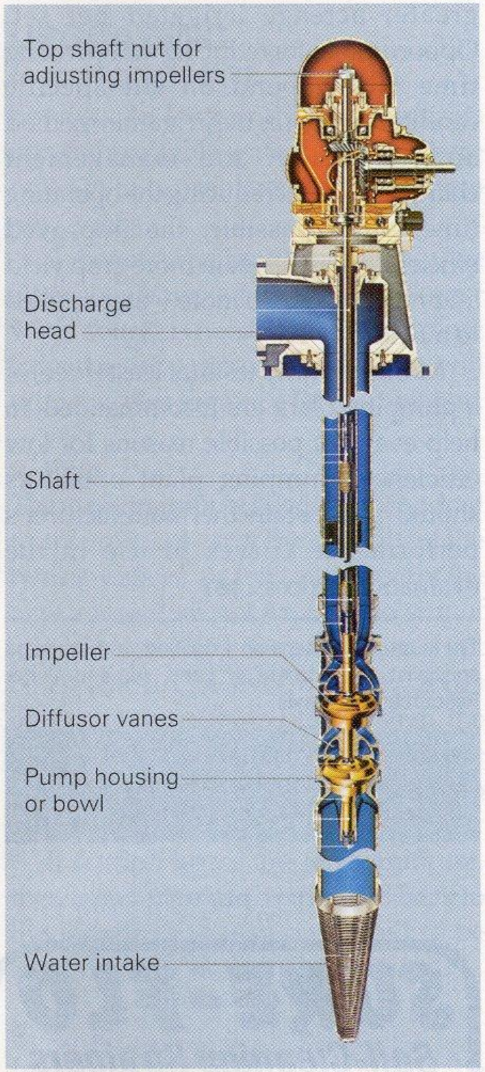


Figure 4-6. Turbine pump

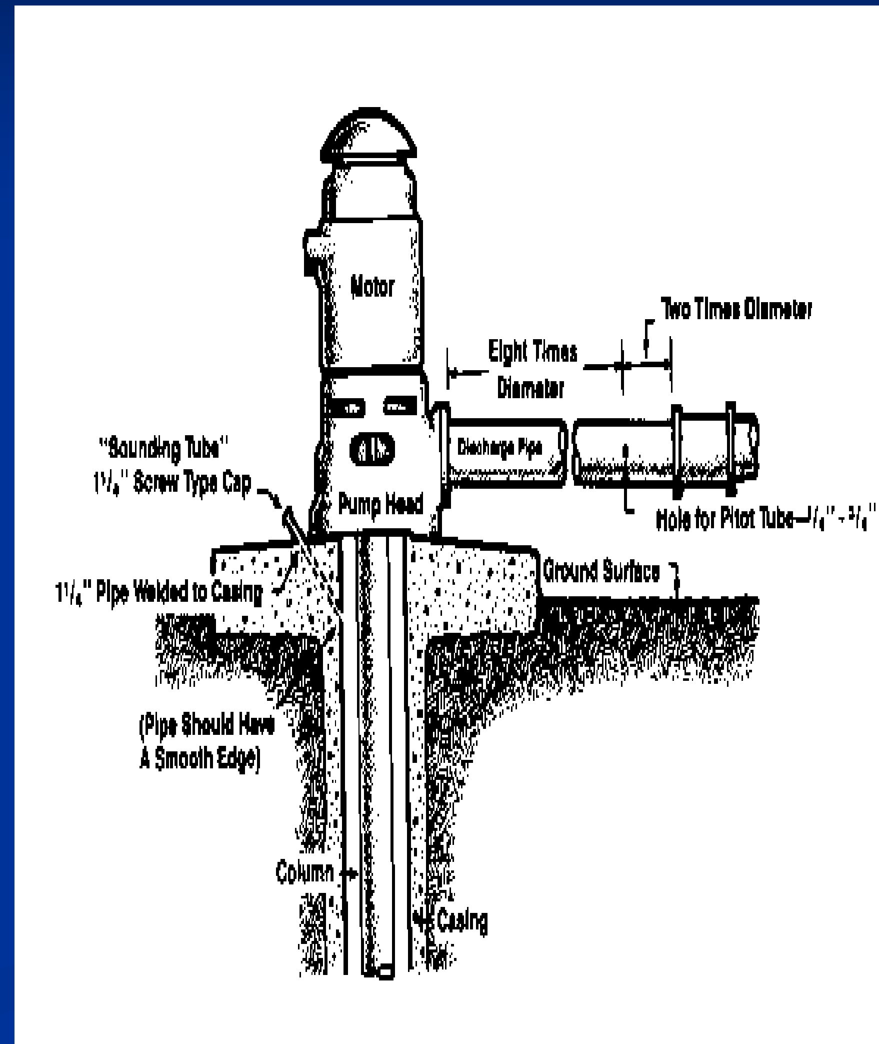
www.delawarewatersupply.com/images/future/wel



Parts of a deep-well turbine.

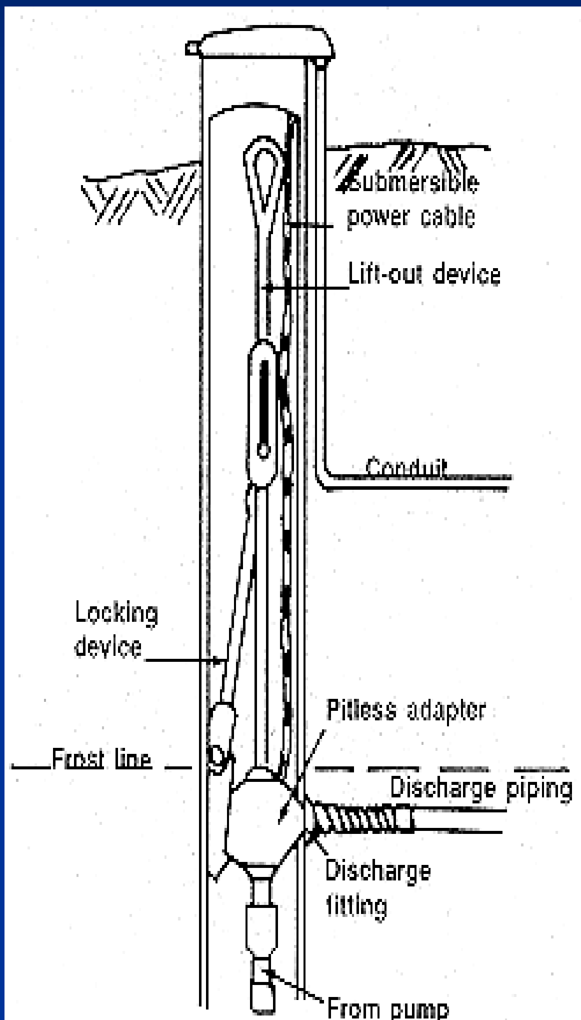
Turbine Pumps - Surface

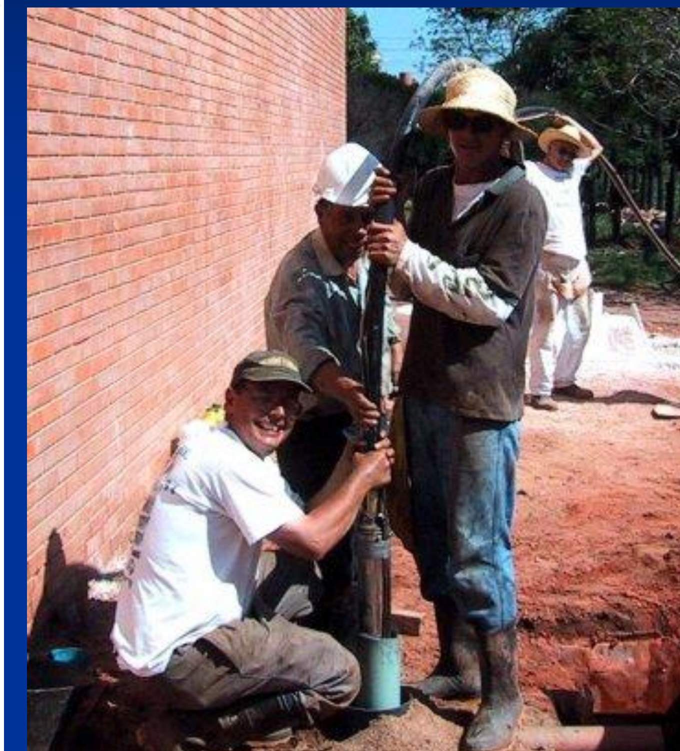
http://www.wh-m.com/mt/wellhead/wellhead.JPG



http://www.bartonvillewater.com/pictures/jerniganwellhead.JPG

Pumps - Submersible





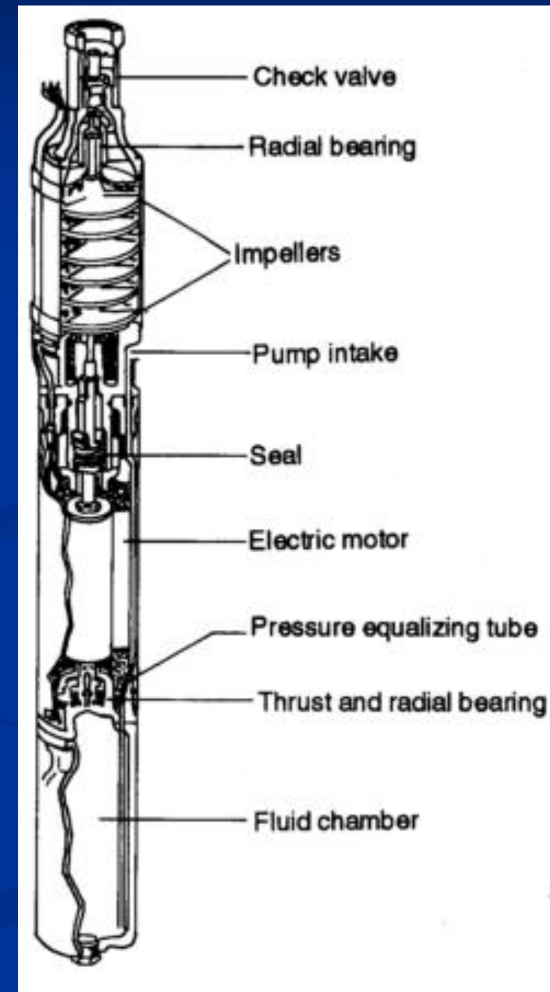
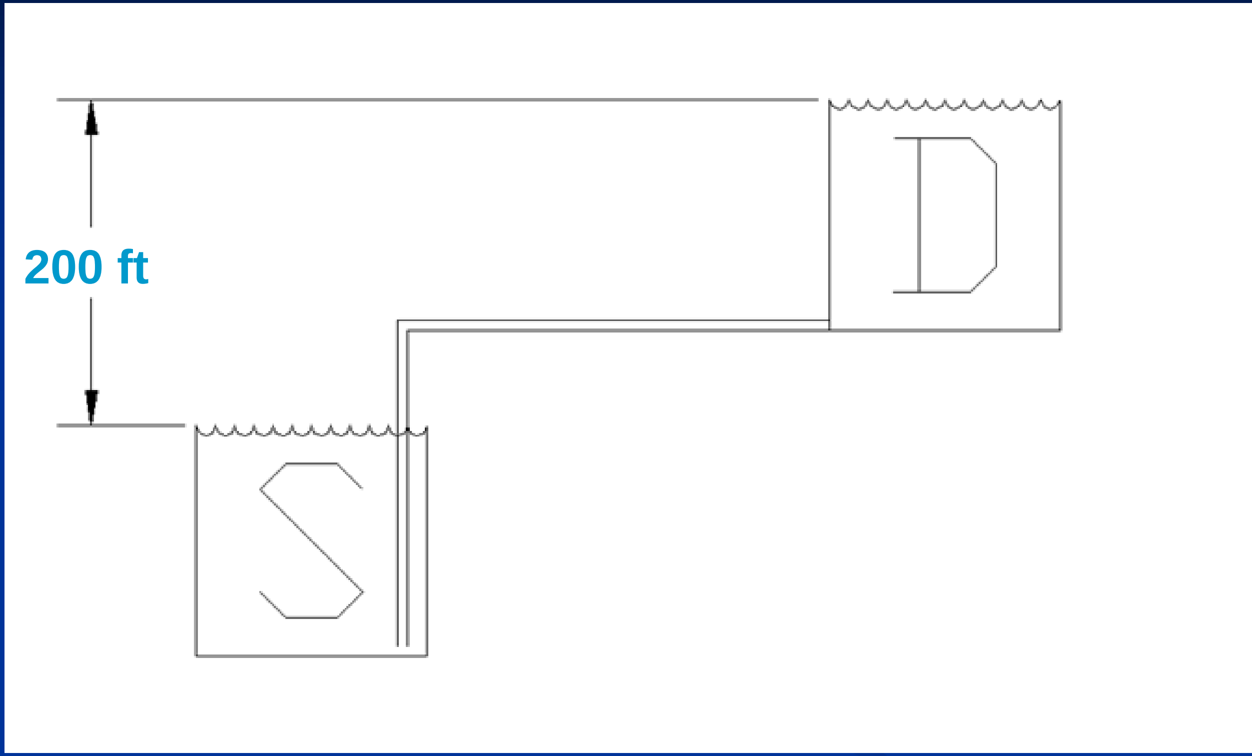


Figure 4-5. Submersible pump

PUMP CURVES

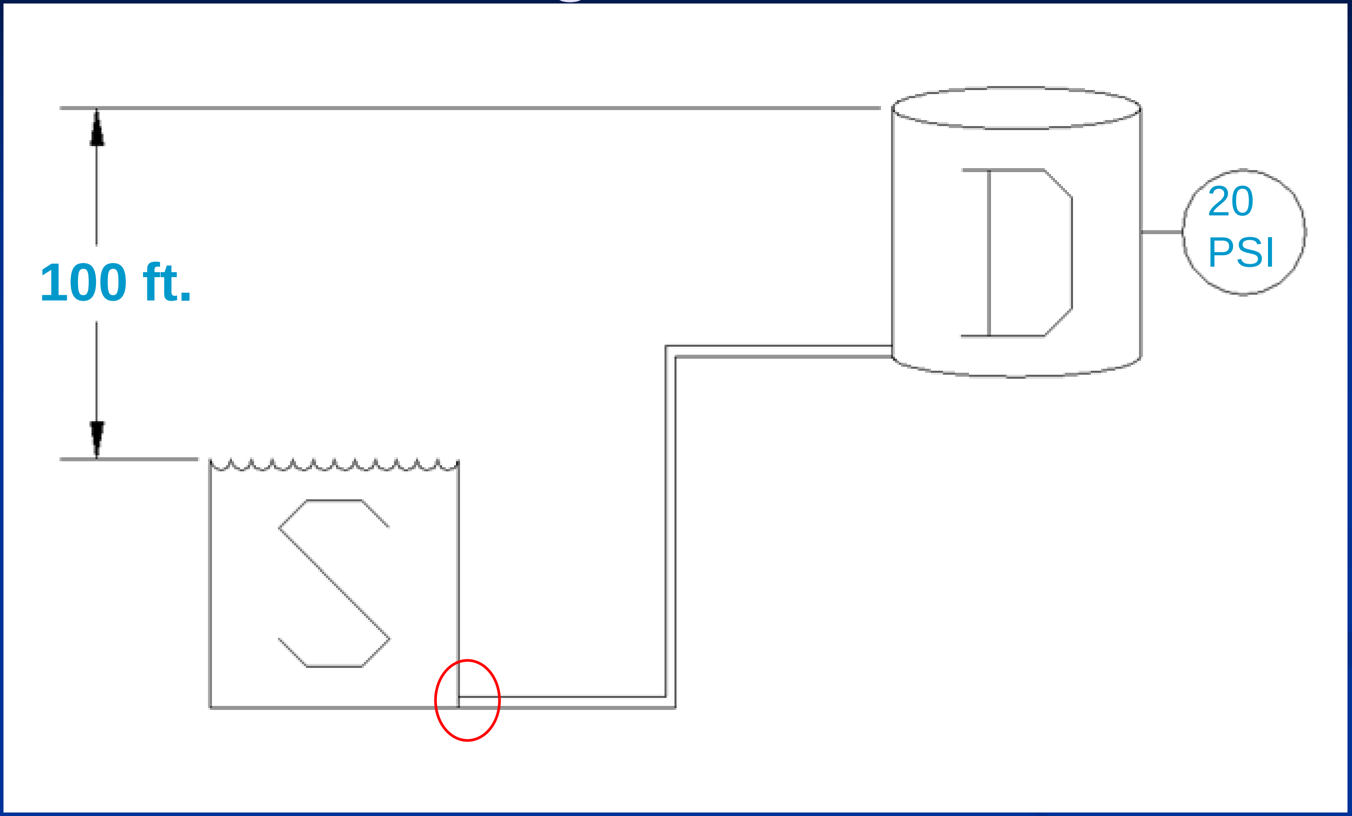
Elevation Head



What is the total elevation head of the above system?

200 ft

Determining Pressure Head

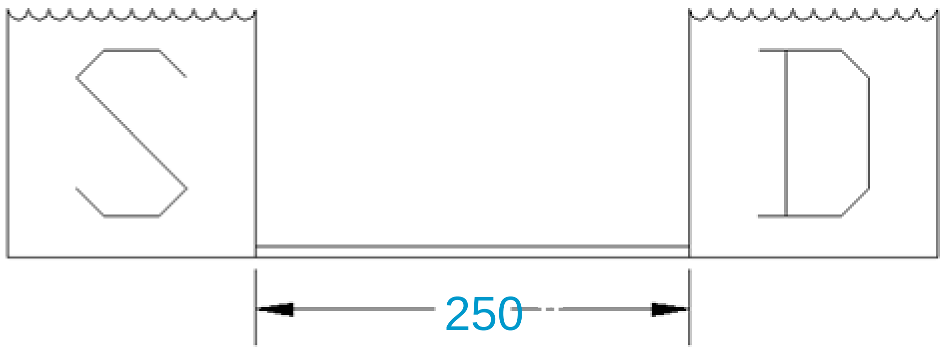


P = 20 PSI
P = 46 ft
H = 100 ft

Pressure Head = 146 ft

Friction Head

@ 16 GPM



Example:
Using 1” Sch40 pipe F.L. = 16.5 ft per 100 ft or 16.5 x 2.5 = 41.25 ft F.L.
With 1” Sch80 pipe F.L. = 26.3 ft per 100 ft or 26.3 x 2.5 = 65.75 ft F.L.

Pipe & Fittings Friction Loss!

What comes back to haunt you later?

Determining Friction Head

VELOCITY CHART & FRICTION OF WATER (new steel pipe) at 60° F — 1 INCH						
	STANDARD WEIGHT STEEL - SCH. 40			EXTRA STRONG STEEL - SCH. 80		
	1.049" Inside Diameter			.957" InsideDiameter		
FLOW U.S. GPM	VELOCITY (Ft./Sec.)	VELOCITY (Head Ft.)	**HEAD LOSS (Ft./100 Ft.)**	VELOCITY (Ft./Sec.)	VELOCITY (Head Ft.)	**HEAD LOSS (Ft./100 Ft.)**
2	0.74	.009	**.385**	.89	.01	**.599**
3	1.11	.019	**.787**	1.34	.03	**1.19**
4	1.48	.034	**1.270**	1.79	.05	**1.99**
5	1.86	.054	**1.90**	2.23	.08	**2.99**
6	2.23	.077	**2.65**	2.68	.11	**4.17**
8	2.97	.137	**4.50**	3.57	.20	**7.11**
10	3.71	.214	**6.81**	4.46	.31	**10.80**
12	4.45	.308	**9.58**	5.36	.45	**15.20**
14	5.20	.420	**12.80**	6.25	.61	**20.40**
16	5.94	.548	**16.50**	7.14	.79	**26.30**
18	6.68	.694	**20.60**	8.03	1.00	**32.90**
20	7.42	.857	**25.20**	8.92	1.24	**40.30**
22	8.17	1.036	**30.30**	9.82	1.50	**48.40**
24	8.91	1.23	**35.80**	10.70	1.80	**57.20**
26	9.65	1.45	**41.70**	11.60	2.10	**66.80**
28	10.39	1.68	**48.10**	12.50	2.40	**77.10**
30	11.10	1.93	**55.00**	13.40	2.80	**88.20**
35	13.00	2.62	**74.10**	15.60	3.80	**119.00**
40	14.80	3.43	**96.10**	17.90	5.00	**154.00**
45	16.70	4.33	**121.00**	20.10	6.30	**194.00**

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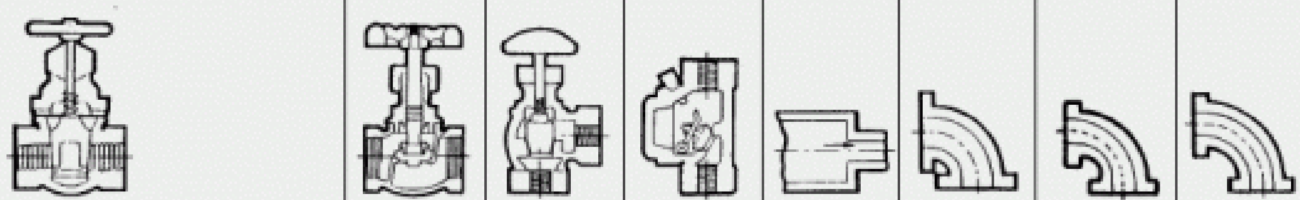
Fitting Friction



FRICTION LOSSES THROUGH PIPE FITTINGS & VALVES

SIZE OF PIPE (Inches)	GATE VALVE WIDE OPEN	GATE VALVE 1/4 CLOSED	GATE VALVE 1/2 CLOSED	GATE VALVE 3/4 CLOSED	GLOBE VALVE-WIDE OPEN	ANGLE VALVE-WIDE OPEN	CHECK VALVE-WIDE OPEN	ORDINARY ENTRANCE TO PIPE LINES	STD. 90° ELBOW	MEDIUM SWEEP 90° ELBOW	LONG SWEEP 90° ELBOW
STRAIGHT PIPE IN FEET (EQUIVALENT LENGTH)											
1/8"	.14	.85	5.00	19.00	9.00	5.00	2.00	.46	.74	.65	.50
1/4"	.21	1.25	7.00	26.00	12.00	6.00	3.00	.60	1.00	.86	.70
3/8"	.27	1.80	9.00	36.00	16.00	8.00	4.00	.75	1.40	1.15	.90
1/2"	.41	2.10	12.00	44.00	17.60	7.78	5.18	.90	1.60	1.55	1.10
3/4"	.55	2.90	14.00	59.00	23.30	10.30	6.86	1.40	2.30	2.06	1.50
1"	.70	3.40	18.00	70.00	29.70	13.10	8.74	1.60	2.70	2.62	2.00
1-1/4"	.92	4.80	24.00	96.00	39.10	17.80	11.50	2.50	3.60	3.45	2.50
1-1/2"	1.07	5.60	28.00	116.00	45.60	20.10	13.40	3.00	4.50	4.03	2.90
2"	1.38	7.00	36.00	146.00	58.60	25.80	17.20	3.50	5.40	5.17	3.60
2-1/2"	1.65	8.40	41.00	172.00	70.00	30.90	20.60	4.00	6.50	6.17	4.40
3"	2.04	10.00	52.00	213.00	86.90	38.40	25.50	5.00	8.50	7.67	5.50
3-1/2"	2.10	12.50	60.00	246.00	100.00	52.00	24.00	5.50	10.0	8.50	6.30
4"	2.40	14.00	70.00	285.00	116.00	57.00	27.00	6.50	12.0	9.50	7.20

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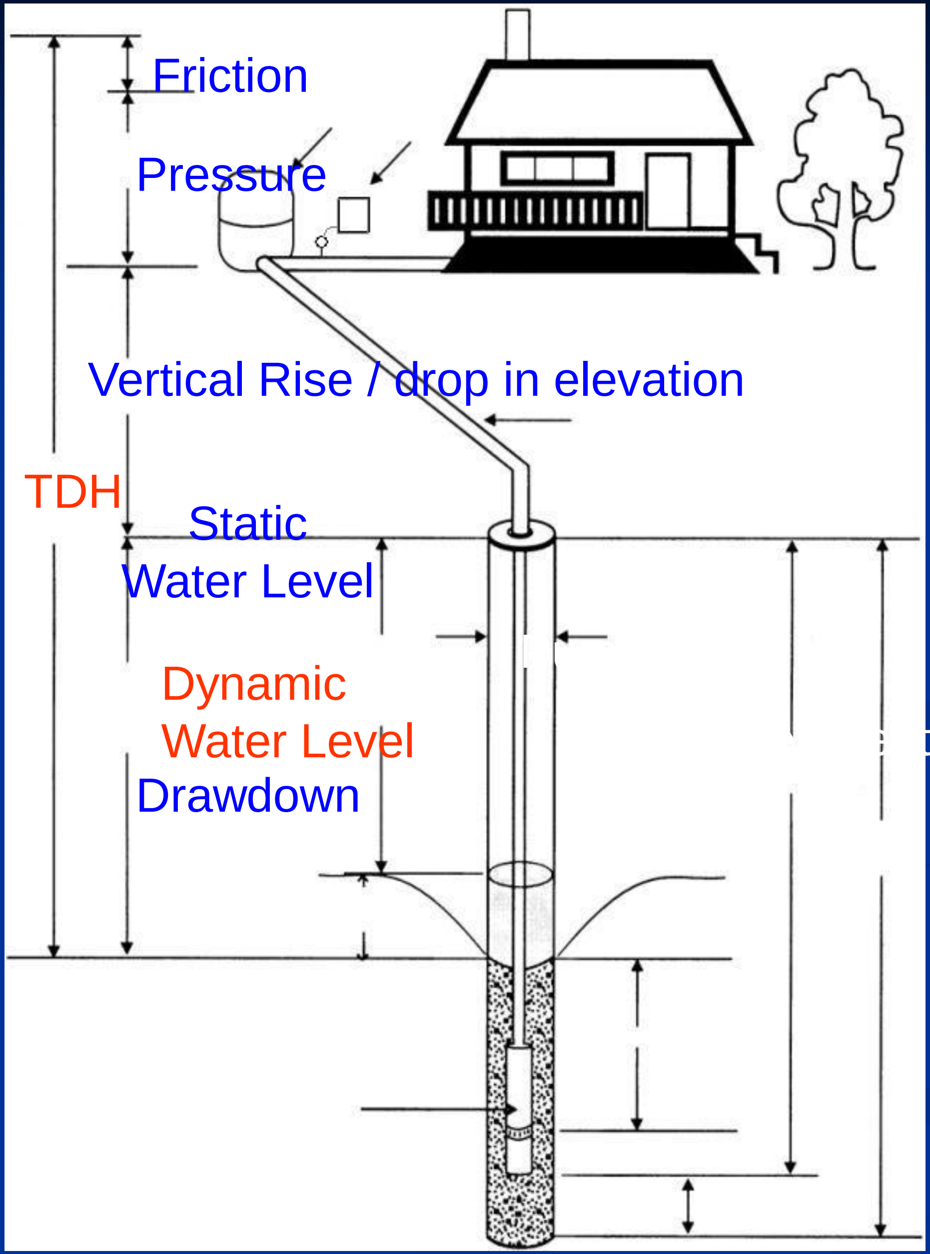
Summary
Calculating TDH
(Total Dynamic Head)



Typical Pump Curve Format

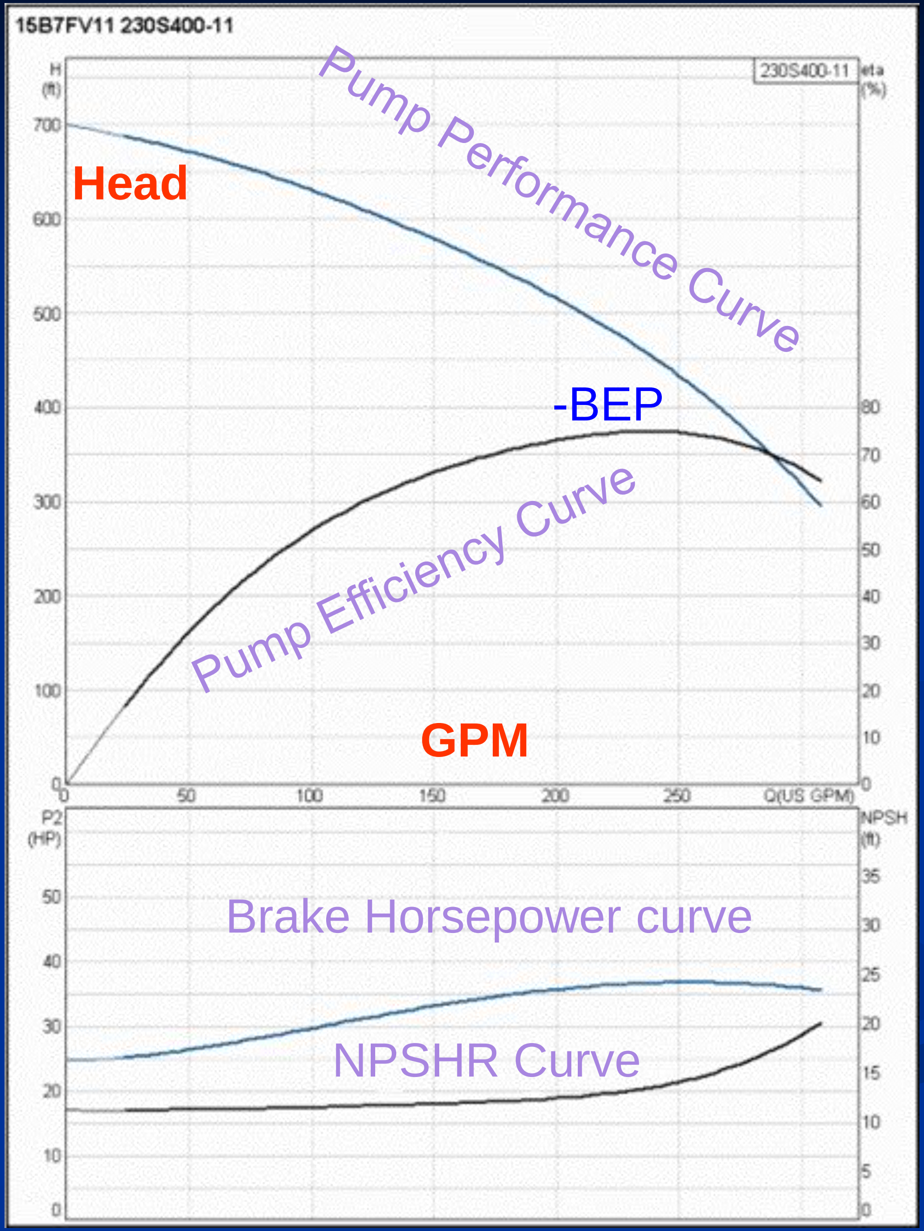
Note: model shown

230S400-11

40 HP

11 STAGE

BEST EFFICIENCY POINT
(BEP) : 230 GPM
77% @ 480 FT.



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What is NSPH?

(Net Positive Suction Head)

CAN BE DEFINED AS THE HEAD THAT CAUSES LIQUID TO FLOW THROUGH THE SUCTION PIPING AND FINALLY ENTER THE EYE OF THE IMPELLER.

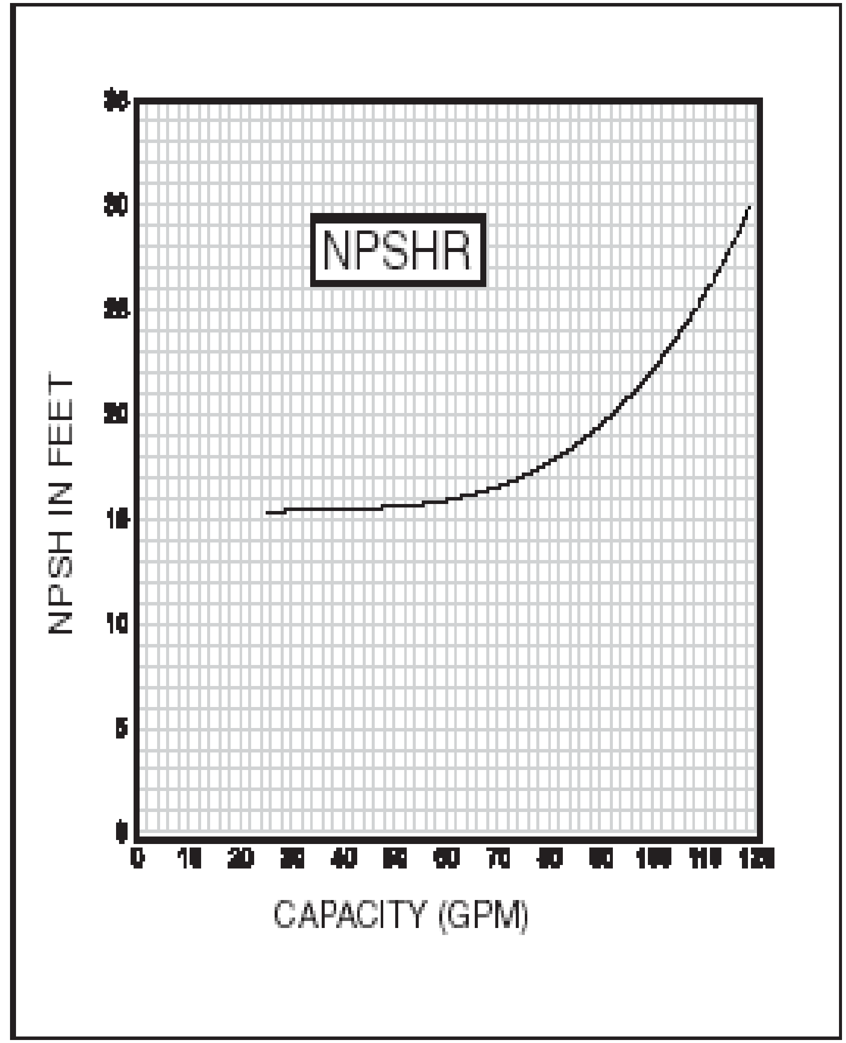
TWO TYPES

NPSHR =
NET POSITIVE SUCTION HEAD REQUIRED.

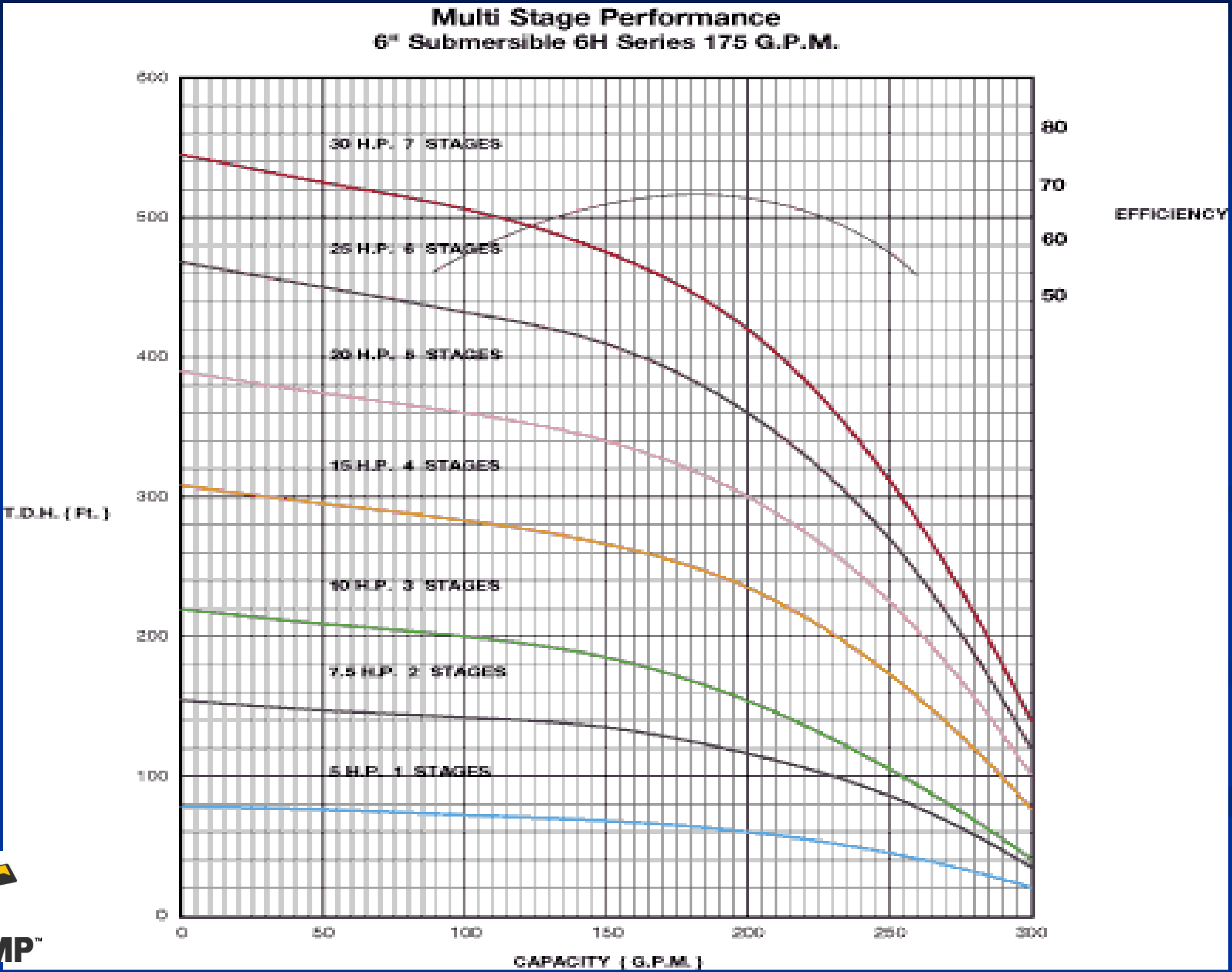
NPSHA =
NET POSITIVE SUCTION HEAD AVAILABLE.

OR in the case of submergible

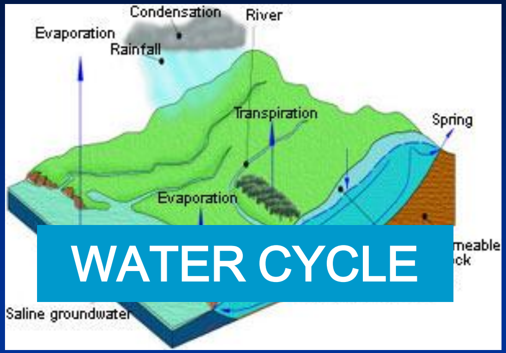
MINIMUM SUBMERGENCE.

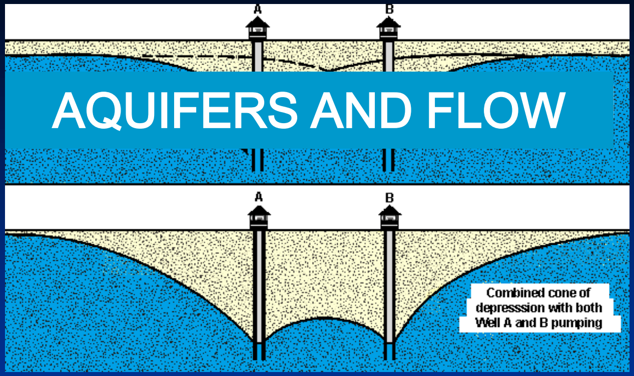


Pumps - Pump Curves and Selection



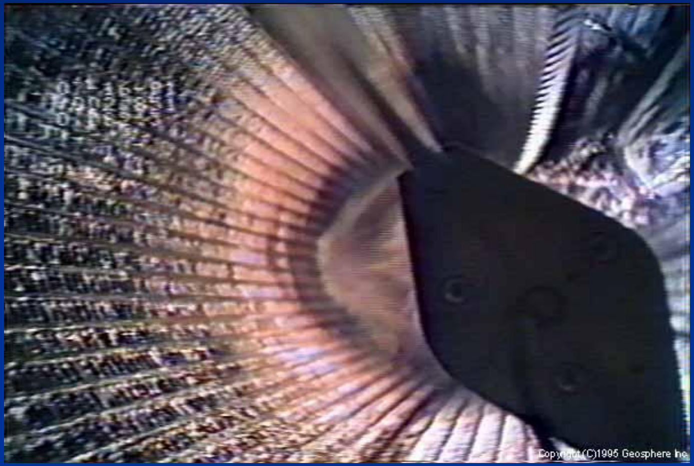
Groundwater & Wells





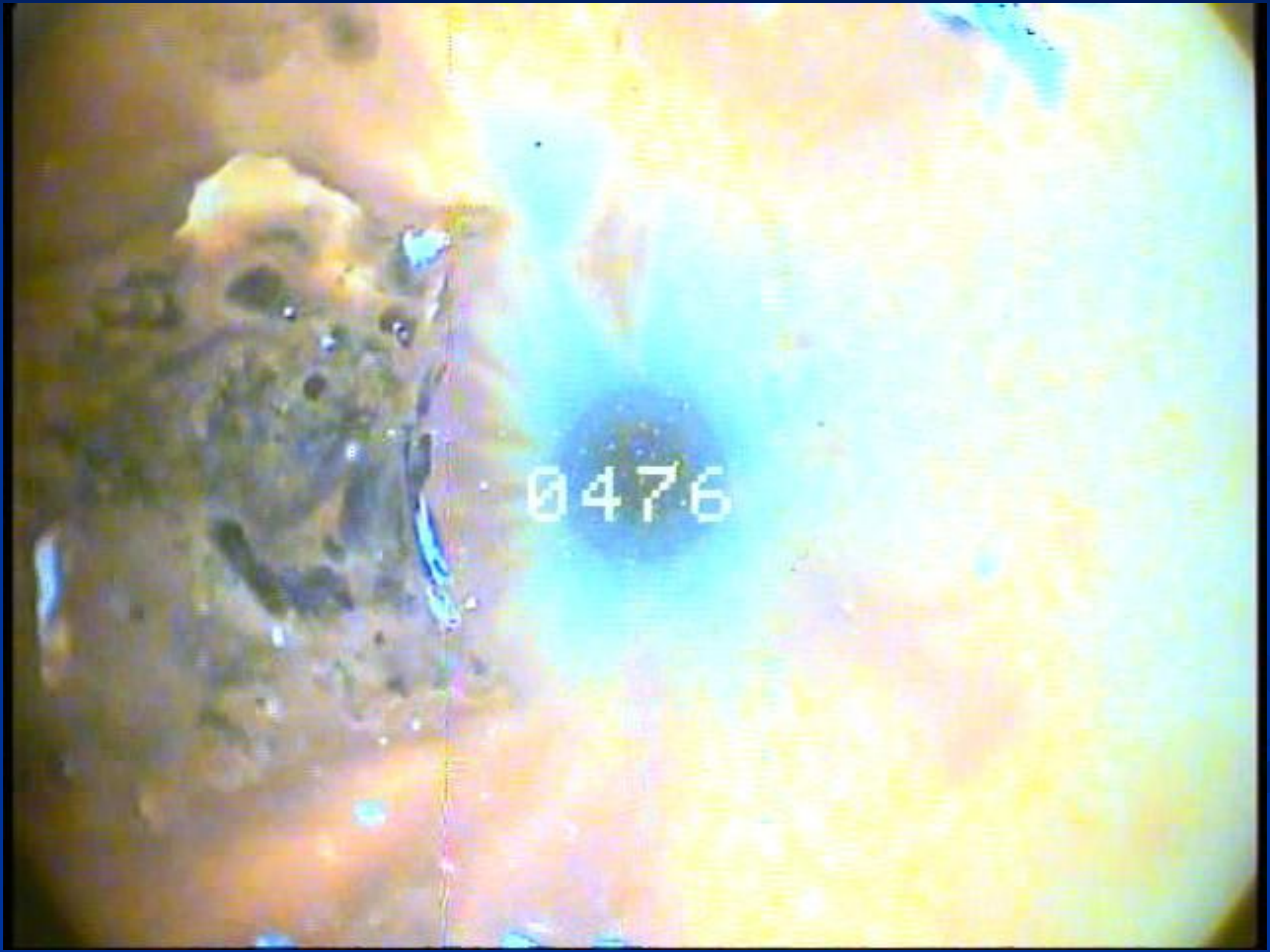
Well Problems and Troubleshooting

WELL PROBLEMS



http://www.geosphereinc.com/dhole.htm

PVC Casing Melts



Things Crack and Misalign

Chemical Composition

- Ph: Chemical composition of the liquid determines what materials of construction a pump should be.
- Mineralization can cause scale build up or clogging in piping & equipment.

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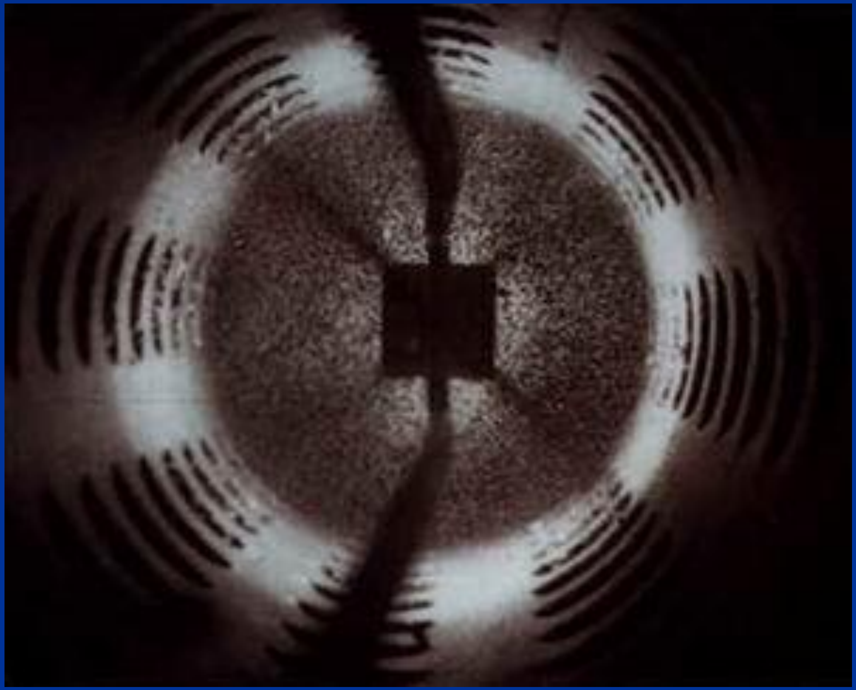
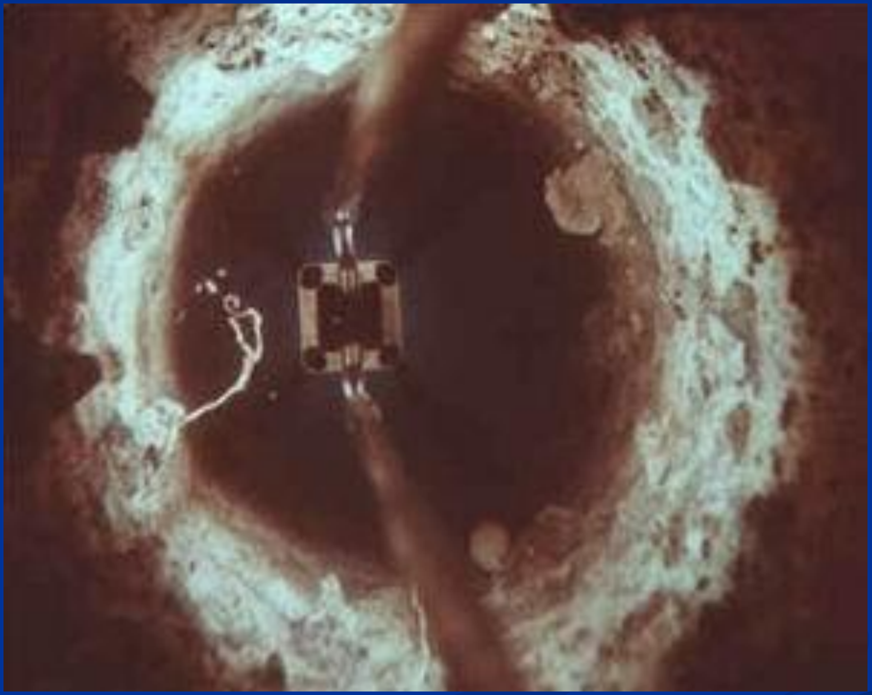
Things Grow

Well Problems

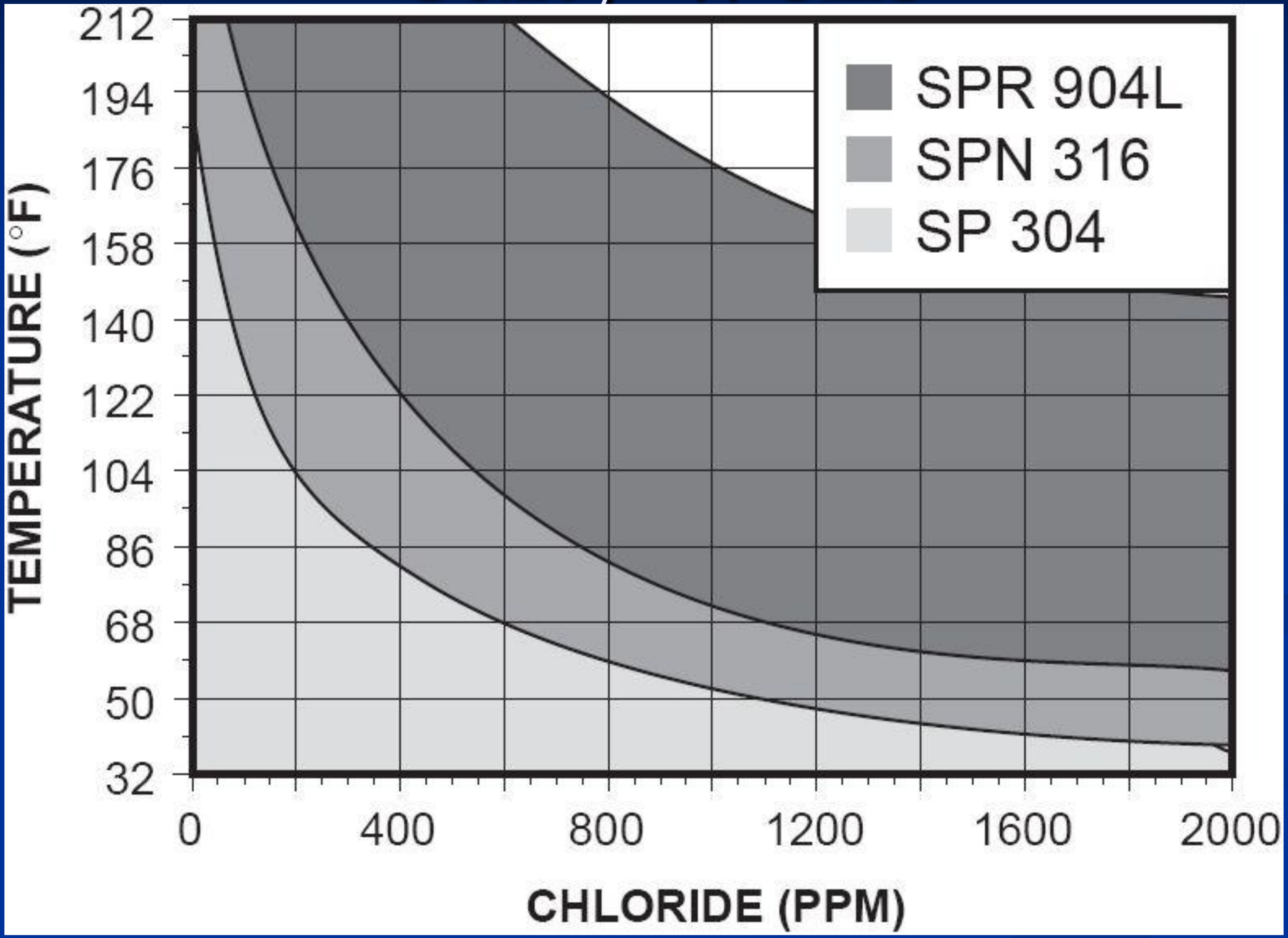


Your Well How You Installed It In 1952



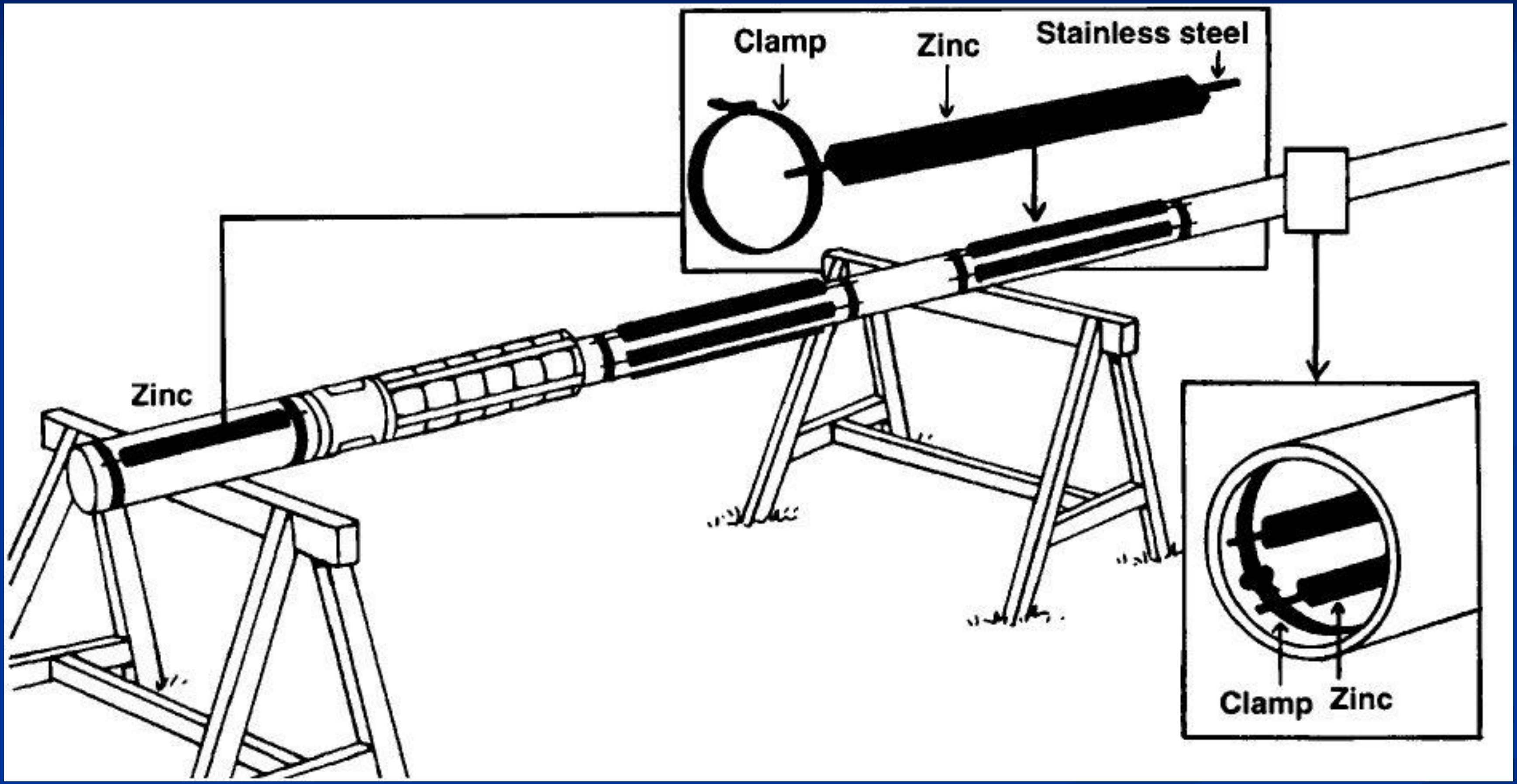
Your Well As It Was Just Before It……

Salty Wells



SPR 904L
SPN 316
SP 304
TEMPERATURE (°F)
212
194
176
158
140
122
104
86
68
50
32
0
400
800
1200
1600
2000
CHLORIDE (PPM)

Anode Protection



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Sandy Wells

- Premature failure of rotating parts due to abrasive action.
- Premature elastomers failure (Motors, Pumps, Valves & Seals).
- Lower than rated flows & pressures (Clogging / Obstructions / Wear)
- Increased operating cost (Maintenance & Replacement)

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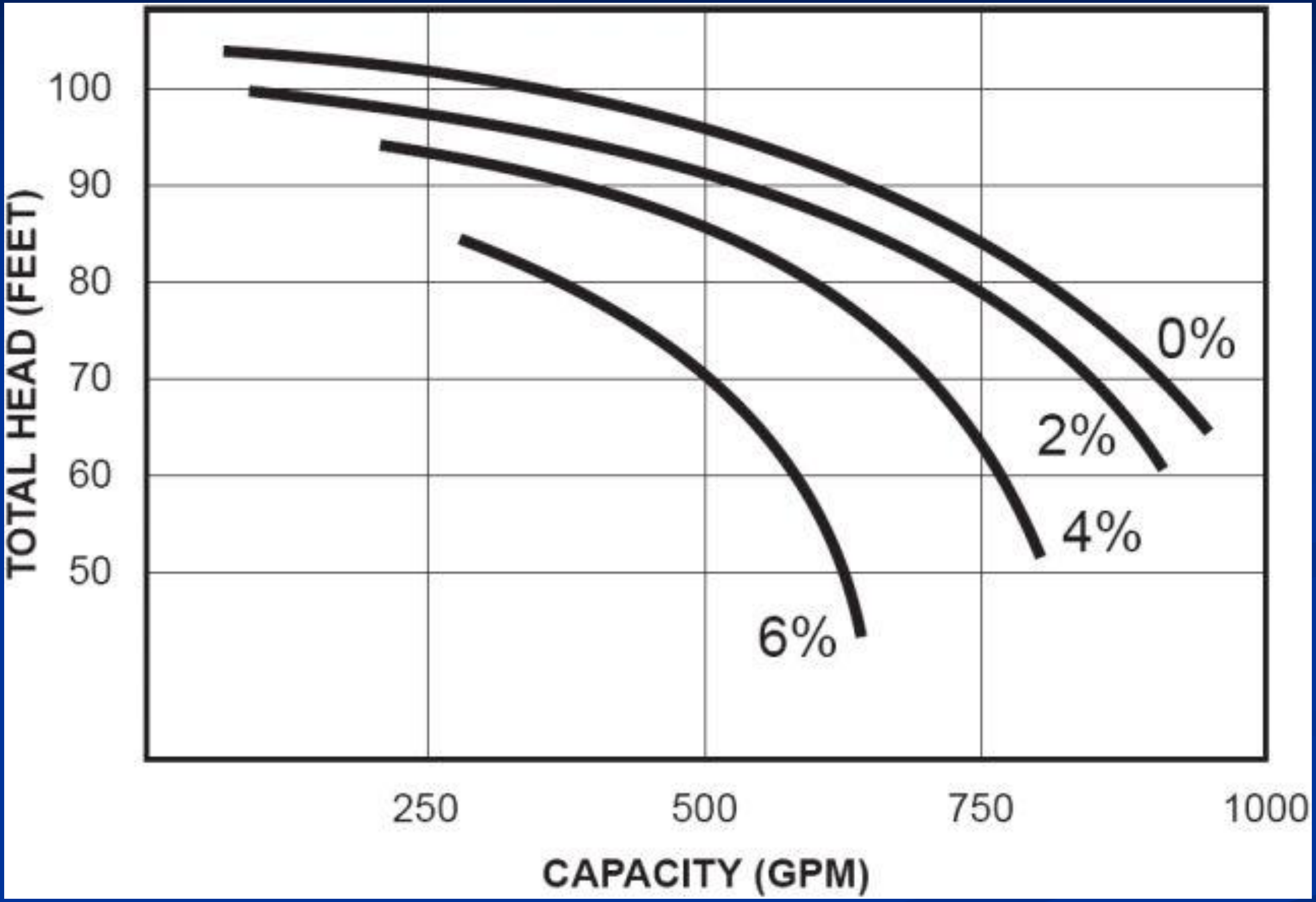
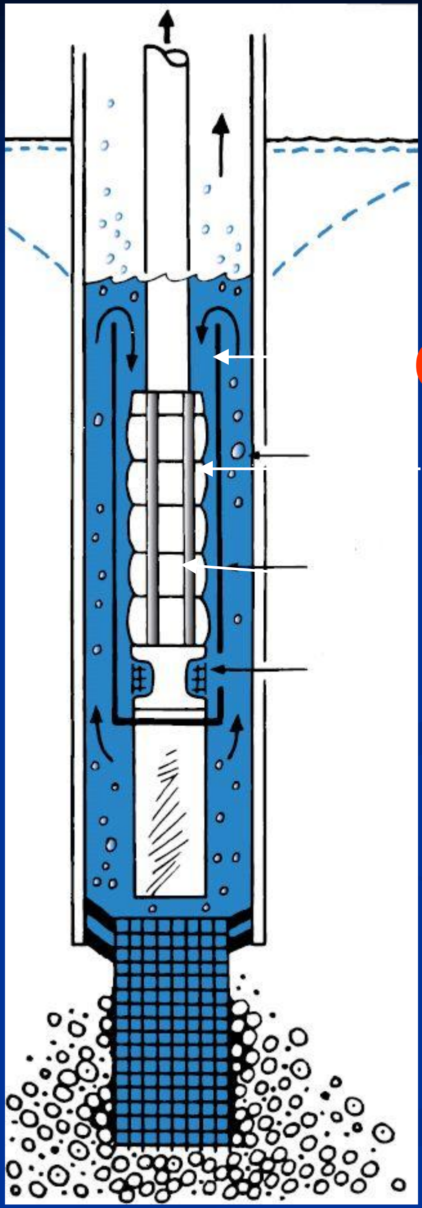
Entrained Gas





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Increasing Temperature (T)

1. Increases Chemical Attack
2. Damages / Weakens Elastomers
3. Increased mineral build - up
4. Damages Motor (loss of cooling)

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Low Producing Well

- Higher than anticipated heads
  (Static water level - Draw – down)

- Up-thrusting from extreme draw-down

- Increased cost due to additional protections for run-dry

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Well Problems – Iron Bacteria

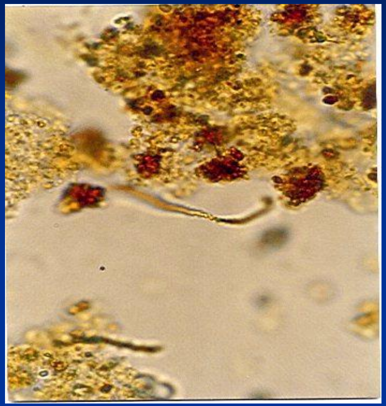

Photo 1: Biofilm Encrustation on Well 15 Pump

Well Problems – Iron Bacteria

Treatments:

Product	Company	Character/ form	Specific use	Currently used in MPWA	Positives	Negatives	Contact
ALBA, ALBA PLUS (Liquid Antibacterial Acid)	Chemdrex Chemicals	Liquid	Kills bacteria, dissolves encrustations and eliminates iron staining	Not reported	Non volatile, can be pumped directly into bore	Minimal toxic fumes, may be corrosive	Chemdrex Chemicals (02) 42566569
Boresave Liquid, Boresave Ultra C	Aquabiotics	Ultra C is an organic crystalline acid with biocidal copper compounds	Dissolves encrustations, biocidal (kills bacteria)	Not reported	Can be added directly to bore, dissolves encrustations	Boresaver Ultra C requires follow up use of Boresaver liquid on a weekly basis	Aquabiotics Pty. Ltd. 14 Goongarrie St Bayswater, WA, Free call Australia: 1800 670 050
Chlorine based solutions: Chlorine Bleach (White King, IGA) Pool Chlorine, Chlorine Tablets, Calcium hypochlorite, Sodium hypochlorite	(Various suppliers)	Liquid and powder forms	Disinfectant, surface sterilisation	Yes	Generally cheap and safe to use	Corrosive to metals, generally only works for a short term, does not dissolve encrustations	Lameroo Pumps & Electrical, 86 Railway Terrace North, Lameroo, 8576 3137. Olson Distributors, Geranium 5301, Machinery Agents 27 Chandos Tce, (08) 8577 2215, 0428 548 665
Clearbore, X-Fe	Clearbore Pty. Ltd.	Oxalic acid, indicator dye in granulated form	Dissolve sludge and encrustations from iron bacteria, X-Fe removes iron staining	Yes	Non corrosive biodegradable reported to be more affective than chlorine	Hazardous product, harmful if swallowed, inhaled or comes in contact with eyes or skin. Has to be mixed with large amounts of water when applied to bore	John Stokes, Unit 11, 26 Terrace Rd Po Box 347, North Richmond NSW 2754, 61 2 4571 3040
Electrolytic Chlorinator	SA Water	Electrolytic chlorinator attached to the pump which produced chlorine via electrolysis of groundwater	Disinfects bore and inhibits bacterial growth	Not reported	Inhibits growth of bacteria, and therefore the biofilms	Does not remove encrustations or biofilms, biofilms may need to be removed mechanically before use	SA Water: 1800 729 938 fax: (08) 8410 1429
Iron and Sulphate Bacteria Control Systems, Pumpmate, Borevac, Screen Clean	Biostat Engineering	Machine which uses copper anodes to electrolytically produce a controlled dose of copper salts in a vat at the bore head which is then injected into the borehole water	Inhibits bacterial growth	Not reported	Inhibits growth of bacteria, and therefore the biofilms	Does not remove encrustations or biofilms	69 Oats St Carlisle, WA 6101, P.O Box 429, Telephone (08) 9472 6466
Triple7 Envirobore	Environmental Fluid Systems	Liquid	Removes iron bacteria. Dose into system to inhibit iron and bacteria growth	Yes	Organic registered, non-hazardous, non-corrosive, add direct to bore Inhibits growth of bacteria & therefore biofilms.	Non known	Environmental Fluid Systems 39 Coghlans Road Warnambook VIC 3280 Phone 03 5561 1400 Fax 03 5561 6255
Triple7 Enviroscale			Removes iron / calcium scale		Dissolves encrustations		

For more information please contact the SA Murray-Darling Basin Natural Resources Management Board on 08 8582 4477

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Photos.

We thank Peter Forward, SA Water, for his contribution of photographs and technical assistance throughout the project.

Table 1. Quantities of chlorine material to use for each 10 feet of water in the irrigation well.

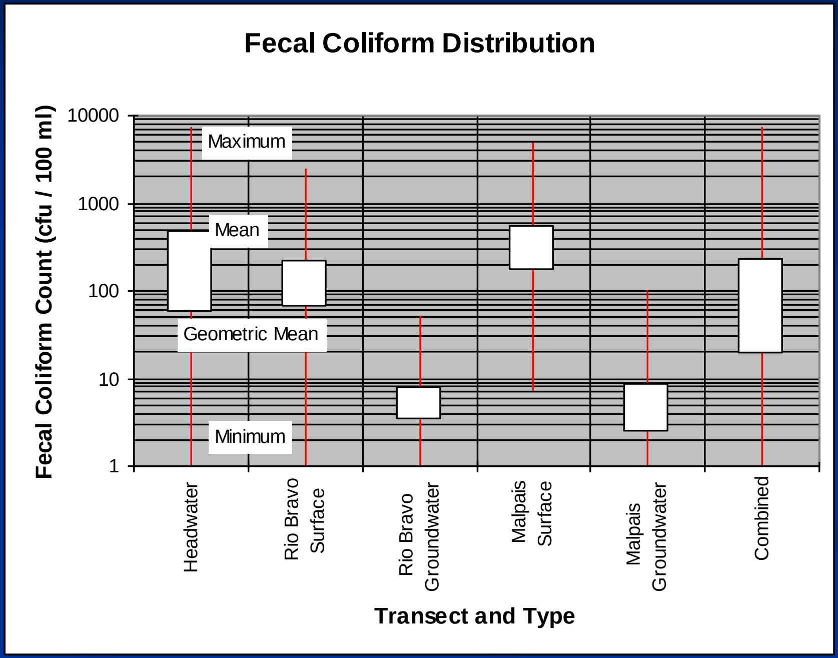
Well Diameter	Gallons of Water in a 10 ft column	HTH 70% Chlorine	Bleach 5% Chlorine
(inches)		(pounds/10 ft)	(gallons/10 ft)
6	15	0.1	0.1
8	26	0.16	0.2
10	41	0.25	0.4
12	59	0.35	0.6
14	80	0.5	0.8
16	105	0.6	1.0
18	133	0.8	1.2
20	164	1.0	1.5
24	235	1.4	2.2

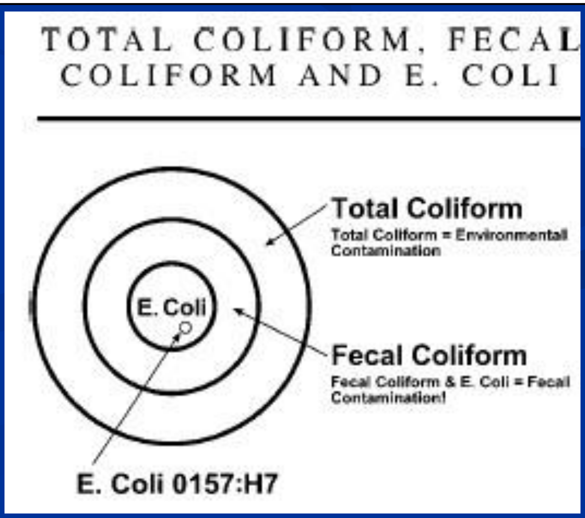
Chemical	Volume (litres)
Chlorine (12.5% sodium hypochlorite)	25
Arccsperse CB-4 Wetting Agent	200
Hydrochloric Acid (31.4%)	680
Caustic Soda (50%)	225
Hot Water (80ºC - 85ºC)	25,000
TOTAL	26,130

www.rivermurray.sa.gov.au/…/ironbacteria.jpg

www.agr.gc.ca/pfra/water/swwinb15.htm

Well Problems – Coliform Bacteria





Motor Does not Start

No power or incorrect voltage.	Check voltage @ line terminals, voltage must be $\pm$ 10%
Fuses blown or circuit breakers tripped	Check or replace fuse , reset breakers
Defective pressure switch	Check contacts. Improper contact can affect line voltage.

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Motor Does not Start

Control Box Malfunction	Repair or replace
Defective wiring	Check for loose or corroded connections or defective wire
Bound pump	Check for misalignment. Sand or trash bound pump 3 to 6 time higher amps
Defective lead or motor	Repair or replace

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Motor Starts to Often

Pressure switch	Check settings & examine for defect
Check Valve – stuck open	Damaged or defective will not hold pressure
Waterlogged tank	Check air charge or bladder
Leak in system	Check system for leaks & repair

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Motor Runs Continuously

▪ Pressure switch	▪ Check switch for welded contacts or adjust settings lower
▪ Low water level in well	▪ Shut off pump & wait for recovery. ▪ Check static & draw-down ▪ Do not lower pump if sand may clog

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Motor Runs Continuously

- Worn Pump

- Symptoms of worn pump are similar to those of drop pipe leak or low water level. Reduce press. switch setting, if pump shuts off worn parts may be the fault

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Motor Runs Continuously

■ Loose coupling or broken motor shaft	■ Replace worn or damaged parts
■ Pump screen blocked	■ Check for clogged intake screen
■ Check valve stuck closed ■ Control box malfunction	■ Check operation of valves
	■ Repair or replace

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Motor runs but overload protection trips

Incorrect voltage	Using voltmeter check line terminals. Voltage must be $\pm$ 10% of rated voltage
Overheated protectors	Direct sunlight or other heat source can raise box temperature Box should not be hot to the touch

Motor runs but overload protection trips

▪ Defective control box	▪ Repair or replace
▪ Defective motor or cable	▪ Repair or replace
▪ Worn pump or motor	▪ Repair or replace

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Thanks to the management at Bernalillo County Public Works for time to prepare and participate

DAN McGREGOR , CPG-09335 ph: 505-848-1578